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COST-EFFECTIVENESS STUDIES OF SANITARY SEWERAGE SYSTEMS

METHODOLOGY AND DEMONSTRATION

VEENSTRA AND KIMM

PREPARED FOR
ENVIRONMENTAL PROTECTION AGENCY

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FINAL DRAFT
February 15, 1974

Prepared for the
Planning Assistance Branch
Water Planning Division
ENVIRONMENTAL PROTECTION AGENCY
EPA CONTRACT No. 68-01-1891

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COST-EFFECTIVENESS STUDIES OF
SANITARY SEWERAGE SYSTEMS

TASK 1:
COST COMPARISON ASSOCIATED WITH ELIMINATING
EXTRANEOUS FLOW PROBLEMS IN EXISTING SANITARY SEWER SYSTEM

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METHODOLOGY

TASK 1: COST COMPARISON ASSOCIATED WITH ELIMINATING EXTRANEOUS FLOW PROBLEMS IN EXISTING SANITARY SEWER SYSTEM

The development of areawide waste treatment management systems includes evaluation of the existing sanitary sewer system. Portions of existing sanitary sewer systems of many metropolitan areas are hydraulically overloaded. Upstream development, sewer pipe and joint deterioration, foundation and roof drain connections and unintentional connections of storm sewers and area intakes are some of the factors contributing to the overloaded conditions. Many of the overloaded conditions are experienced only during periods of wet weather and high ground water elevations. When this condition exists it indicates extraneous waters are entering the sanitary sewer system to cause the surcharged conditions.

Surcharged sanitary sewers can cause wastewater back-up into basements and pollution of surface waters. Surface water pollution occurs when wastewater flows out of the top of the manhole onto the ground surface. These conditions create a public health problem by exposing the public to raw wastewater. Wastewater back-up usually causes considerable damage to private properties. When this occurs, property owners often seek court judgments against the local government for the damages. These conditions point

out the need for an evaluation of methods or plans for handling the extraneous flow in the sanitary sewer system.

This methodology outlines the procedures for determining the most cost-effective method of eliminating extraneous flow problems in an existing sanitary sewer system serving a drainage basin within a metropolitan area. The procedures used are in accordance with the EPA cost-effectiveness guidelines set out in Title 40 CFR Part 35. The general approach is to determine if excessive infiltration/inflow conditions exist based on the evaluation of alternate plans for eliminating the extraneous flow problems. Excessive infiltration/inflow is defined in proposed EPA guidelines as "the quantities of infiltration/inflow which can be economically eliminated from a sewer system by rehabilitation, as determined by a cost-effectiveness analysis that compares the cost for correcting the infiltration/inflow conditions with the total costs for transportation and treatment of the infiltration/inflow.".

The first step in the solution of the problem of excessive flows is the study of the existing sanitary sewer system to determine possible causes of flows in excess of the hydraulic capacity. This study involves the determination of the contributing population, analysis of the water usage of the contributing population, the

existence of foundation drain connections, field investigations for possible extraneous water sources, calculation of hydraulic capacities of the various portions of the system, installation of flow gauging stations and the correlation of complaints with rainfall records and the elevation of the ground water table. The results of these studies will define the trouble areas and indicate the areas or sources of the extraneous water. The study will indicate whether or not the existing sanitary sewers have capacity for the expected dry weather flows. Before installation of flow gauging stations, all roof drain connections to the sanitary sewer, cross-connections between the sanitary and storm sewers, and surface water intakes should be disconnected from the sanitary sewer system. If the above work is extensive, elimination of these connections is included in the cost-effectiveness analyses and the flow contribution from these sources will have to be determined.

In the past, in areas where high ground water conditions are known to exist, it was common practice to install drain tile lines around each foundation constructed in these areas. Existing records or the field investigations will show where foundation drain tile lines have been connected to the sanitary sewer. In such areas, it is beneficial to determine the magnitude of

flow from several of these foundation tile drain systems. Usually, it is possible to find in the study area, foundation drains that discharge through an exposed wall opening in the foundation or into a floor drain. If such installations can be found, the flows from these foundation tile drain lines can be measured and used to obtain a representative value for foundation drain flow in the study area.

Generally, extraneous flow conditions are more severe in the trunk and sub-trunk sewers in the drainage basin sanitary sewer system. These sewers are often surcharged while the tributary lateral sewers still have adequate capacity and are relatively free of surcharge. Therefore, for study purposes, the sanitary sewer system is usually divided into separate sub-trunk sewer system areas. The flow gauging stations should be located near the outlet of each sub-trunk sewer and at the outlet of the trunk sewer. The magnitude of the various flow components can then be determined. Flow measurements should be taken during both dry and wet weather conditions. It is desirable that the flow gaugings be conducted concurrently at all stations. If the drainage basin is large, it will probably be necessary to select representative sub-areas from which to measure flow rates. In turn, the results of these flow measurements can be used to

estimate the flows from the remaining sub-areas.

The objective of the system investigations and flow gaugings is to separate the various components of wastewater flow and determine the magnitude of each component. These data are needed for the analyses to determine the most cost-effective method of eliminating the extraneous flow problems. The flow components should be separated as follows:

1. Average and peak wastewater flows
2. Dry weather infiltration
3. Wet weather infiltration
4. Foundation drainage
5. Other significant contributions.

In residential areas, wastewater flows may be determined from water usage records and population data and substantiated with actual flow gaugings. In industrial and commercial areas, more extensive studies may be required. Sewer infiltration quantities may be determined from flow gauging records and should be correlated with rainfall and ground water conditions. Infiltration into the trunk or sub-trunk sewers may be determined by subtracting the infiltration of the tributary lateral and sub-trunk sewers in the sub-areas from the total infiltration.

Representative samplings of water from foundation tile drain systems is necessary if the quantity of water from that source is to be separated from the total quantity of extraneous water entering the sanitary sewer system. Each sanitary sewer system must be studied to determine if there are other significant contributions. This segment of the total flow, if present, will have to be determined for each study area.

In addition, future development in the drainage basin must be considered. The relationships between flow rates, together with projected population increases, can be used to determine flows expected in the future. Projections should be on an incremental development basis, determined by the area remaining to be developed, population increases brought about by such development and possible year of development. Information required to make these projections may be obtained from census data, land use plans, engineering studies and data supplied by regional planning organizations. Based on the projections, staged construction of improvements may be advantageous.

Results of the above analyses will suggest possible alternate methods for eliminating the extraneous flow problems. The selection of these alternates for evaluation should include

consideration of environmental and social impacts in addition to monetary aspects. Further, all alternates must provide compliance with applicable Federal, State and local criteria, particularly water quality standards.

Basic alternates which should be considered are as follows:

1. Provide sewer capacity to convey all flows to wastewater treatment facilities and expand the treatment facilities to treat these flows.

2. Rehabilitate the lateral, sub-trunk and trunk sewers to reduce the extraneous flows to a rate so that the remaining flow can be handled in the existing sewerage system.

3. Separate or eliminate one or more components of flow from the system; such as that from foundation drains if its magnitude will reduce the remaining flow so that it can be handled in the existing sewerage system.

4. Any combination of the above to reduce extraneous flows to a cost-effective level.

All alternates are screened to determine those with cost-effectiveness potential. The most cost-effective alternate is determined in

accordance with EPA guidelines using present worth calculations based on a planning period of 20 years and an annual interest rate of 7 percent.

This interest rate should be used until the promulgation of the Water Resources Council's "Proposed Principles and Standards for Planning Water and Related Land Resources". After promulgation of this regulation, the annual interest rate established therein for water resources projects shall be used for cost-effectiveness analyses of the components of sanitary sewerage systems.

Total costs for each alternate must be estimated. These costs should include total values of the resources attributable to each alternate. Elements of total cost include capital construction cost, annual operation and maintenance costs and equipment replacement costs. As set out in Title 40 CFR Part 35, capital costs must include:

> "...all contractors' costs of construction including overhead and profit; cost of land, relocation and right-of-way and easement acquisition; design engineering, field exploration and engineering services during construction; administrative and legal services including cost of bond sales; startup costs such as operator training; and interest during

construction. Contingency allowances consistent with the level of complexity and detail of the cost estimate shall be included.".

The above items should reflect present-day costs; no attempt should be made to forecast future inflation or deflation trends. Estimates should reflect costs in the locale of the study area. Construction costs may be obtained from bids received locally for similar construction, reference materials and from equipment and materials manufacturers. To adjust construction cost amounts to reflect present-day cost, a recognized construction cost index, that accounts for changing prices for labor, material and equipment, may be used. Interest during construction is equal to (I)(P/2)(C), where:

I = the interest rate (7%) expressed as a decimal

P = the construction period in years

C = total capital expenditure in dollars,

provided the expenditures are expected to be relatively uniform over the construction period and provided the construction period is 3 years or less. Title 40 CFR Part 35 provides additional guidance if these conditions are not expected.

Annual operating and maintenance costs for each alternate must be established. These costs shall be adequate to ensure effective and dependable operation and include all costs for operating and maintaining the facilities under study including power, labor, parts, materials, overhead, chemicals and repair or replacement of equipment and structures. Annual operation and maintenance costs may be obtained from records for similar facilities, reference materials and calculations of work required. Inflation or deflation trends shall not be considered. Annual costs should be divided between fixed costs and those dependent upon the annual quantity of wastewater collected and treated.

Cost-effectiveness analyses also include establishing a service life for each component and salvage values for components having service lives longer than the planning period. The following service lives are to be used, unless other periods can be justified:

Land	Permanent
Structures	30-50 Years
Process Equipment	15-30 Years
Auxiliary Equipment	10-15 Years

The most cost-effective alternate is determined by present worth calculations. The general computation required is as follows:

Present Worth = Total capital construction cost

plus (+)

total capital construction cost for staged construction times single payment present worth factor based on 7% and years from time of analysis

plus (+)

average annual operation and maintenance cost times uniform series present worth factor based on 7% and 20 years (staged construction may alter this computation)

plus (+)

replacement costs, based on 7% and service life, if service life is less than 20 years and

minus (-)

salvage values times single payment present worth factor based on 7% and 20 years, if service life is greater than 20 years.

In summary, considering monetary aspects only, the most cost-effective alternate is the plan having the least present worth, as determined above. The size and importance of the project should be reflected in the degree of sophistication and extent of effort used in the cost-effectiveness analysis.

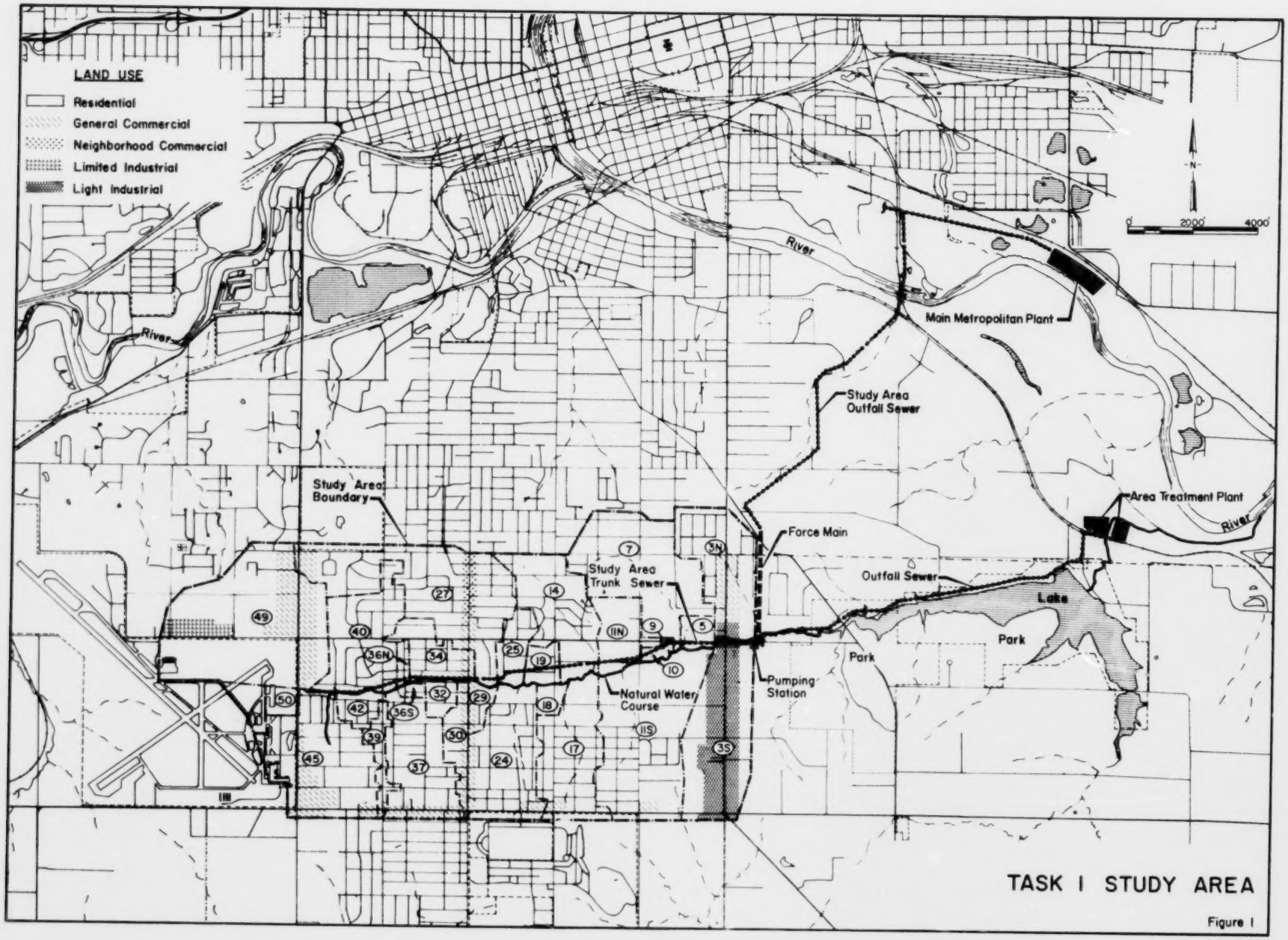
DEMONSTRATION

TASK 1: COST COMPARISON ASSOCIATED WITH ELIMINATING EXTRANEOUS FLOW PROBLEMS IN EXISTING SANITARY SEWER SYSTEM

This demonstration is an illustrative example of the cost-effectiveness analysis procedures outlined in the Methodology. The demonstration compares alternate methods for eliminating problems caused by extraneous flow in an existing sanitary sewer system.

The study area for this demonstration, shown on Figure 1, is located in a metropolitan area. At present, wastewater from the study area is treated by the main metropolitan wastewater treatment plant. Since the study area is not in the same drainage basin as the plant, a pumping station, force main and outfall sewer are required to transport the wastewater to the plant. In addition, another outfall sewer extends from the pumping station to an area treatment plant. This outfall sewer carries flows in excess of the pumping station capacity to the area treatment plant. These facilities are shown on Figure 1.

The natural drainage pattern of the study area is influenced by the water course which bisects the area in an east-west direction. The water course gradient provides approximately 70 feet of


LAND USE
Residential
General Commercial
Neighborhood Commercial
Limited Industrial
Light Industrial
N
0
2000'
4000'
River
River
Main Metropolitan Plant
Study Area Outfall Sewer
Study Area Boundary
Area Treatment Plant
River
Force Main
Study Area Trunk Sewer
Outfall Sewer
Lake
Park
Park
Pumping Station
Natural Water Course
TASK I STUDY AREA
Figure 1

elevation difference between its upper reaches near the airport and its lower reaches near the existing pumping station.

Drainage toward the water course is caused by ground surface elevation differences of up to 50 feet between areas near the study area boundary and the water course. Predominant soils in the study area are silty loam topsoils underlain with impervious clays extending to bedrock. This is typical of the soil formations of many midwestern communities.

Land use in the study area is primarily residential. However, commercial and industrial developments exist along some arterial streets. The study area is near full development at the present time. No significant increases in population or wastewater flow rates are likely to occur in the future.

The sanitary sewer system serving the study area includes a trunk sewer which generally parallels the water course and lateral and sub-trunk sewers which collect wastewater from the 28 sub-areas tributary to the trunk sewer. Most of the sewers in the study area were constructed in the period of the early 1950's to the mid 1960's.

During wet weather periods, the sewer system collects large

quantities of extraneous flows. These high flow rates exceed the capacity of the trunk sewer and the pumping station. As a result, basements flood and raw wastewater flows into the water course out of the top of surcharged manholes. These conditions cause a health hazard in the study area near the natural water course and affect the aquatic life in the lake located downstream from the study area. Numerous complaints have been received from area residents and several lawsuits have been initiated against the City to collect damages resulting from basement flooding.

As a result of the problems caused by sewer surcharging, the City initiated a study program to investigate the sewer system to determine the sources and magnitude of extraneous flows. Flow gauging stations were installed in the sewer system at outlets of selected sub-areas and flow data were collected. Flow data and complaint records were correlated to determine which sub-areas were most affected by excess flows. It was found that most of the sewers were in the same general condition and records of flow data and complaints indicated the problem was areawide. As a result of this correlation, it was possible to study selected representative areas and apply the results to the remaining sub-areas.

Four fully developed sub-areas were selected for study, as follows:

1. Sub-area 39, a small sub-area of 31 acres, which was developed in the 1950's.
2. Sub-areas 17 and 45, medium sized sub-areas of 142 acres and 122 acres, which were developed in the 1960's.
3. Sub-area 14, a recently developed, medium sized sub-area of 112 acres.

Data from the flow gauging stations were used to determine the extent of the extraneous flows into the sanitary sewer system in each of the four sub-areas.

City records indicated that the houses in the study area have foundation drains which discharge to the sanitary sewers. It was necessary to establish the contribution from the foundation drains to separate this quantity from infiltration attributed to other sources of extraneous water. The flow from foundation drains was measured at houses selected at random.

Table 1 is a compilation of data on wastewater flow rates and daily loadings from each of the sub-areas. These data are the result of the study of the four selected sub-areas and application of this information to the remaining sub-areas. The flow contributions comprising total peak wet weather flow are as follows:

Peak Wastewater Flow	5.96 cfs
Foundation Drainage	21.08 cfs
Peak Wet Weather Infiltration	18.16 cfs
TOTAL	45.20 cfs

Analysis of the existing sewer system indicated that it has adequate capacity for peak dry weather commercial, domestic and industrial wastewater flows. The system, as designed, has capacity for nominal amounts of infiltration. However, present infiltration and foundation drainage far exceed the capacity available. On the basis of the data obtained from the preliminary studies, all possible alternate methods for eliminating the extraneous flow problems were screened to determine their cost-effectiveness potential. Social and environmental impact factors were considered, however, discussion of the social and environmental impact factors is beyond the scope of this demonstration.

TABLE 1
DAILY LOADINGS

Area No.	Population	Average Dry Weather Flow, cfs	Peak Wet Weather Flow, cfs	Daily Loadings	
				Organic lbs. BOD5	Suspended Solids, lbs.
3N	1,750	0.42	3.45	298	350
3S	650	0.15	1.28	111	130
5	130	0.03	0.26	22	26
7	2,340	0.56	4.61	398	468
9	45	0.02	0.09	8	9
10	45	0.02	0.09	8	9
11N	480	0.11	0.94	82	96
11S	1,820	0.43	3.59	309	364
14	1,120	0.26	2.21	190	224
17	1,420	0.34	2.80	241	284
18	90	0.02	0.17	15	18
19	280	0.06	0.56	48	56
24	1,640	0.39	3.68	279	328
25	480	0.11	0.94	82	96
27	2,940	0.70	5.80	500	588
29	220	0.05	0.43	37	44
30	370	0.09	0.73	63	74
32	160	0.03	0.31	27	32
34	920	0.22	1.81	156	184
36N	70	0.02	0.14	12	14
36S	70	0.02	0.14	12	14
37	1,310	0.31	2.58	223	262
39	310	0.08	0.62	53	62
40	1,410	0.34	2.79	240	282
42	290	0.06	0.57	49	58
45	*	0.36	3.02	260	306
49	*	0.19	1.50	129	152
50	*	0.02	0.09	9	10
	20,360	5.41	45.20	3,861	4,540

*Flow rates and wastewater characteristics were determined by field measurements.

Six alternates having the highest cost-effectiveness potential were selected for evaluation in accordance with the guidelines set out in Title 40 CFR Part 35. The six alternates are described as follows:

Alternate 1

The installation of a sump pump in each basement having a foundation drain with the pump discharge piped to a new lateral storm sewer system which will flow by gravity to the water course. In most instances, the storm sewer system will be constructed at an elevation above the basement floors of the buildings to be served.

Alternate 2

The construction of a new lateral storm sewer system located below the floor levels of basements. Flow from foundation drains to the sewers will be by gravity. The flow will be discharged to lateral and sub-trunk storm sewers tributary to the water course. The alignment of the storm sewers may have to parallel the water course for a short distance until gravity discharge is possible.

Alternate 3

This alternate continues the present practice of discharging

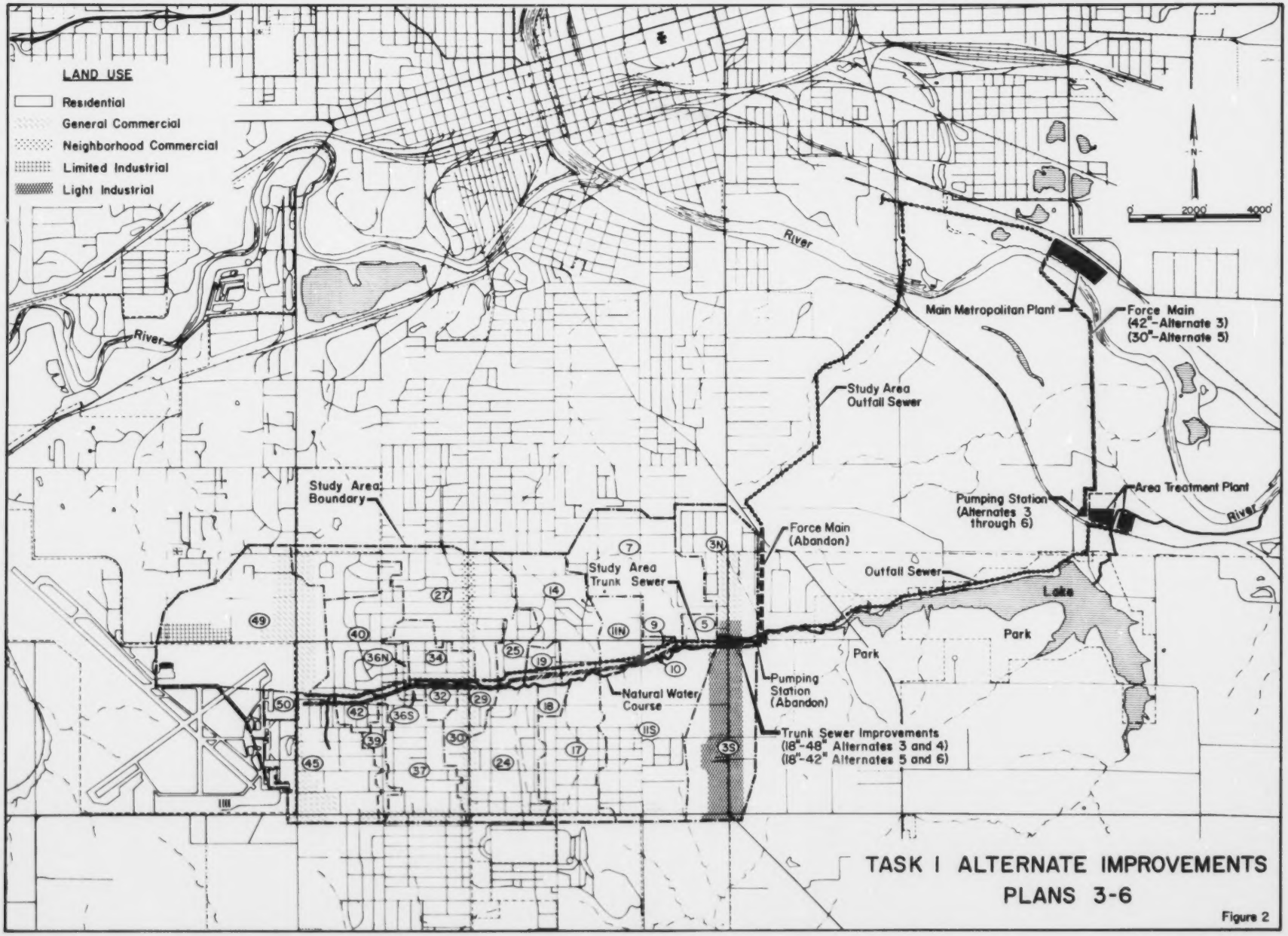
foundation drainage into the sanitary sewer system. Construction includes abandoning the existing pumping station and force main and constructing new such facilities where shown on Figure 2. The existing study area trunk sewer is utilized and a new relief trunk sewer roughly paralleling the existing sewer is required to carry the flow in excess of the existing sewer capacity. Also, this alternate provides for treatment facilities at the Main Metropolitan Plant to treat study area storm water flows.

Alternate 4

This alternate continues the present practice of discharging foundation drainage into the sanitary sewer system. Construction includes utilizing the existing study area trunk sewer, a relief trunk sewer, abandoning the existing pumping station and force main, utilizing the existing outfall sewer to convey flow to the Area Treatment Plant. Enlargement of the Area Treatment Plant to provide capacity for treating study area wastewater and storm flow is required. A pumping station is required at the Area Treatment Plant site.

Alternate 5

This alternate is similar to Alternate 3 in that wastewater


LAND USE
Residential
General Commercial
Neighborhood Commercial
Limited Industrial
Light Industrial
N
0
2000'
4000'
River
River
Main Metropolitan Plant
Force Main
(42"-Alternate 3)
(30"-Alternate 5)
Study Area
Outfall Sewer
Study Area
Boundary
Pumping Station
(Alternates 3
through 6)
Area Treatment Plant
River
Force Main
(Abandon)
Study Area
Trunk Sewer
Outfall Sewer
Lake
Park
Park
Pumping
Station
(Abandon)
Natural Water
Course
Trunk Sewer Improvements
(18"-48" Alternates 3 and 4)
(18"-42" Alternates 5 and 6)
7
3N
27
14
49
40
11N
9
5
25
19
36N
34
10
50
32
29
18
42
36S
11S
39
30
17
35
45
37
24
TASK I ALTERNATE IMPROVEMENTS
PLANS 3-6
Figure 2

treatment is provided at the Main Metropolitan Plant and a new pumping station and force main is required, as shown on Figure 2. The existing study area trunk sewer is utilized, together with the construction of a relief trunk sewer to carry the flow in excess of the existing sewer capacity. This alternate also includes cleaning, inspection and rehabilitation of all existing sewers in the study area.

The present infiltration rate is approximately 4,000 gallons per day per inch-diameter per mile of pipe. The long term effect of rehabilitation of the existing system was estimated to reduce infiltration to approximately 2,000 gpd/inch-dia./mile.

Alternate 6

This alternate includes cleaning, inspection and rehabilitation of all existing sewers in the study area and as in Alternate 4, provides facilities to convey the flow to the Area Treatment Plant and provides for increasing the capacity of the area plant to treat all the flow from the study area. The existing study area trunk sewer is utilized, together with the construction of a relief trunk sewer.

Tables 2 through 7 are summaries of the improvements required by each alternate plan and show the estimated costs for each

improvement. Estimated unit prices reflect September, 1973, construction costs and include the costs of labor, materials, equipment, allowances for contractor's overhead and profit and for project start-up. Unit prices for constructing sewers, pumping stations, force mains, treatment plants and appurtenances reflect bid prices for similar construction in the locale of the study community, adjusted to the September, 1973, Engineering News-Record Construction Cost Index of 1931.01, based on year 1913 = 100. No attempt is made to forecast future inflation or deflation trends. Estimates assume construction by contracts awarded on basis of competitive bids.

Estimated construction contract costs are determined by adding a contingency allowance of 10% to the sum of the extended unit prices to allow for unforeseen conditions arising prior to or during construction. Total estimated project costs are determined by adding to the estimated construction contract costs an allowance of 18% of such costs for technical, administrative and legal services, the costs of land and easements, and the amount of interest that will accrue during construction.

TABLE 2

ESTIMATED PROJECT COST - ALTERNATE 1

Description	Unit	Estimated Quantity	Unit Price	Extended Price
House Services				
Sump and Sump Pump	Ea.	7,000	$150.00	$1,050,000
Sump Pump Discharge Pipe (2")	LF	420,000	5.00	2,100,000
Connections to Sewer	Ea.	7,000	50.00	350,000
Lateral Storm Sewer System (3' to 9' depth)				
8" Pipe in Place	LF	300,000	6.00	1,800,000
10" Pipe in Place	LF	15,000	8.00	120,000
12" Pipe in Place	LF	10,000	10.00	100,000
Manholes, Standard	Ea.	1,200	400.00	480,000
Street Replacement	Ea.	330	200.00	66,000
Driveway Replacement	Ea.	3,500	150.00	525,000
			SUB-TOTAL	$6,591,000
Contingencies (10%+)				659,000
			ESTIMATED CONSTRUCTION CONTRACT COST	$7,250,000
Technical, Administrative and Legal Services (18%+)				1,305,000
Easements				24,000
Interest During Construction				601,000
			ESTIMATED PROJECT COST	$9,180,000

TABLE 3

ESTIMATED PROJECT COST - ALTERNATE 2

Description	Unit	Estimated Quantity	Unit Price	Extended Price
House Services				
Service Pipe (4")	LF	420,000	$ 5.50	$2,310,000
Connections to Sewer	Ea.	7,000	50.00	350,000
Connections to Foundation Drains	Ea.	7,000	75.00	525,000
Lateral Storm Sewer System (8' to 10' depth)				
8" Pipe in Place	LF	300,000	9.00	2,700,000
10" Pipe in Place	LF	15,000	10.00	150,000
12" Pipe in Place	LF	10,000	12.00	120,000
Manholes, Standard	Ea.	1,200	525.00	630,000
Street Replacement	Ea.	330	350.00	115,500
Driveway Replacement	Ea.	3,500	150.00	525,000
			SUB-TOTAL	$7,425,500
Contingencies (10%±)				742,500
			ESTIMATED CONSTRUCTION CONTRACT COST	$8,168,000
Technical, Administrative and Legal Services (18%±)				1,470,000
Easements				24,000
Interest During Construction				676,000
			ESTIMATED PROJECT COST	$10,338,000

TABLE 4

ESTIMATED PROJECT COST - ALTERNATE 3

Description	Unit	Estimated Quantity	Unit Price	Extended Price
Trunk Sewer				
(10' to 18' depth)				
18" Pipe in Place	LF	2,275	$ 15.00	$ 34,125
24" Pipe in Place	LF	2,025	20.00	40,500
30" Pipe in Place	LF	1,375	25.00	34,375
36" Pipe in Place	LF	4,165	31.00	129,115
42" Pipe in Place	LF	2,795	36.00	100,620
48" Pipe in Place	LF	940	40.00	37,600
Manholes, Special	Ea.	44	850.00	37,400
Street Replacement	Ea.	5	400.00	2,000
Concrete Encasement				
30"-36" Pipe	LF	100	50.00	5,000
42"-48" Pipe	LF	100	60.00	6,000
Treatment at Main Metropolitan Plant				
Pumping Station				
Structure	Ea.	1	325,000.00	325,000
Equipment	LS	1	125,000.00	125,000
Force Main				
42" Pipe in Place	LF	9,000	48.00	432,000
River Crossing	LF	300	150.00	45,000
Storm Flow Treatment				
Structures	LS	1	500,000.00	500,000
Process Equipment	LS	1	225,000.00	225,000
Auxiliary Equipment	LS	1	175,000.00	175,000
			SUB-TOTAL	$2,253,735
Contingencies (10%±)				225,365
			ESTIMATED CONSTRUCTION CONTRACT COST	$2,479,100
Technical, Administrative and Legal Services (18%±)				446,200
Easements				
Trunk Sewer				13,600
Force Main				9,000
Site Acquisition				
Pumping Station				2,000
Storm Flow Treatment				20,000
Interest During Construction				156,000
			ESTIMATED PROJECT COST	$3,125,900

TABLE 5

ESTIMATED PROJECT COST - ALTERNATE 4

Description	Unit	Estimated Quantity	Unit Price	Extended Price
Trunk Sewer (10' to 18' depth)				
18" Pipe in Place	LF	2,275	$ 15.00	$ 34,125
24" Pipe in Place	LF	2,025	20.00	40,500
30" Pipe in Place	LF	1,375	25.00	34,375
36" Pipe in Place	LF	4,165	31.00	129,115
42" Pipe in Place	LF	2,795	36.00	100,620
48" Pipe in Place	LF	940	40.00	37,600
Manholes, Special	Ea.	44	850.00	37,400
Street Replacement	Ea.	5	400.00	2,000
Concrete Encasement				
30"-36" Pipe	LF	100	50.00	5,000
42"-48" Pipe	LF	100	60.00	6,000
Treatment at Area Treatment Plant				
Pumping Station				
Structure	Ea.	1	325,000.00	325,000
Equipment	LS	1	125,000.00	125,000
Force Main	LS	1	20,000.00	20,000
Wastewater Treatment				
Structures	LS	1	880,000.00	880,000
Process Equipment	LS	1	400,000.00	400,000
Auxiliary Equipment	LS	1	320,000.00	320,000
Storm Flow Treatment				
Structures	LS	1	500,000.00	500,000
Process Equipment	LS	1	225,000.00	225,000
Auxiliary Equipment	LS	1	175,000.00	175,000
			SUB-TOTAL	$3,396,735
Contingencies (10%+)				339,665
			ESTIMATED CONSTRUCTION CONTRACT COST	$3,736,400
Technical, Administrative and Legal Services (18%+)				672,600
Easements				
Trunk Sewer				13,600
Site Acquisition				
Pumping Station				2,000
Wastewater Treatment				7,500
Interest During Construction				232,600
			ESTIMATED PROJECT COST	$4,664,700

TABLE 6

ESTIMATED PROJECT COST - ALTERNATE 5

Description	Unit	Estimated Quantity	Unit Price	Extended Price
Sewer Inspection and Rehabilitation				
Inspection and Cleaning				
8"-15" Pipe	LF	327,620	$ 1.00	$ 327,620
18"-21" Pipe	LF	7,025	2.00	14,050
24"-30" Pipe	LF	5,085	5.00	25,425
Rehabilitation				
8" Pipe	LF	300,000	3.10	930,000
10" Pipe	LF	15,000	3.50	52,500
12" Pipe	LF	11,155	4.00	44,620
15" Pipe	LF	1,465	4.60	6,739
18" Pipe	LF	3,450	5.20	17,940
21" Pipe	LF	3,575	5.80	20,735
24" Pipe	LF	4,145	6.50	26,942
30" Pipe	LF	940	7.80	7,332
Trunk Sewer (10' to 18' depth)				
15" Pipe in Place	LF	2,085	14.00	29,190
24" Pipe in Place	LF	3,090	20.00	61,800
30" Pipe in Place	LF	3,775	25.00	94,375
36" Pipe in Place	LF	2,795	31.00	86,645
42" Pipe in Place	LF	940	36.00	33,840
Manholes, Special	Ea.	44	850.00	37,400
Street Replacement	Ea.	5	400.00	2,000
Concrete Encasement				
30"-36" Pipe	LF	100	50.00	5,000
42" Pipe	LF	100	60.00	6,000
Treatment at Main Metropolitan Plant				
Pumping Station				
Structure	Ea.	1	250,000.00	250,000
Equipment	LS	1	100,000.00	100,000
Force Main				
30" Pipe in Place	LF	9,000	38.00	342,000
River Crossing	LF	300	125.00	37,500
Storm Flow Treatment				
Structures	LS	1	285,000.00	285,000
Process Equipment	LS	1	130,000.00	130,000
Auxiliary Equipment	LS	1	105,000.00	105,000
			SUB-TOTAL	$3,079,653

TABLE 6 - Continued

ESTIMATED PROJECT COST - ALTERNATE 5

Balance Carried Forward	SUB-TOTAL	$3,079,653
Contingencies (10%±)		307,947
	ESTIMATED CONSTRUCTION CONTRACT COST	$3,387,600
Technical, Administrative and Legal Services (18%±)		609,800
Easements		
Trunk Sewers		12,700
Force Main		9,000
Site Acquisition		
Pumping Station		2,000
Storm Flow Treatment		20,000
Interest During Construction		211,900
	ESTIMATED PROJECT COST	$4,253,000

TABLE 7

ESTIMATED PROJECT COST - ALTERNATE 6

Description	Unit	Estimated Quantity	Unit Price	Extended Price
Sewer Inspection and Rehabilitation				
Inspection and Cleaning				
8"-15" Pipe	LF	327,620	$ 1.00	$ 327,620
18"-21" Pipe	LF	7,025	2.00	14,050
24"-30" Pipe	LF	5,085	5.00	25,425
Rehabilitation				
8" Pipe	LF	300,000	3.10	930,000
10" Pipe	LF	15,000	3.50	52,500
12" Pipe	LF	11,155	4.00	44,620
15" Pipe	LF	1,465	4.60	6,739
18" Pipe	LF	3,450	5.20	17,940
21" Pipe	LF	3,575	5.80	20,735
24" Pipe	LF	4,145	6.50	26,942
30" Pipe	LF	940	7.80	7,332
Trunk Sewer (10' to 18" depth)				
15" Pipe in Place	LF	2,085	14.00	29,190
24" Pipe in Place	LF	3,090	20.00	61,800
30" Pipe in Place	LF	3,775	25.00	94,375
36" Pipe in Place	LF	2,795	31.00	86,645
42" Pipe in Place	LF	940	36.00	33,840
Manholes, Special	Ea.	44	850.00	37,400
Street Replacement	Ea.	5	400.00	2,000
Concrete Encasement				
30"-36" pipe	LF	100	50.00	5,000
42" pipe	LF	100	60.00	6,000
Treatment at Area Treatment Plant				
Pumping Station				
Structure	Ea.	1	250,000.00	250,000
Equipment	LS	1	100,000.00	100,000
Force Main	LS	1	20,000.00	20,000
Wastewater Treatment				
Structures	LS	1	880,000.00	880,000
Process Equipment	LS	1	400,000.00	400,000
Auxiliary Equipment	LS	1	320,000.00	320,000
Storm Flow Treatment				
Structures	LS	1	285,000.00	285,000
Process Equipment	LS	1	130,000.00	130,000
Auxiliary Equipment	LS	1	105,000.00	105,000
			SUB-TOTAL	$4,320,153

TABLE 7 - Continued

ESTIMATED PROJECT COST - ALTERNATE 6

Balance Carried Forward	SUB-TOTAL	$4,320,153
Contingencies (10%+)		432,047
	ESTIMATED CONSTRUCTION CONTRACT COST	$4,752,200
Technical, Administrative and Legal Services (18%+)		855,400
Easements		
Trunk Sewers		12,700
Site Acquisition		
Pumping Station		2,000
Wastewater Treatment		7,000
Interest During Construction		295,000
	ESTIMATED PROJECT COST	$5,924,800

The present worth computations for each alternate are summarized in Tables 8 through 13. These computations are based on a planning period of 20 years and an annual interest rate of 7 percent.

The annual expenditures include costs of labor and materials for maintaining the gravity sewers and force mains, electrical power, routine replacement of equipment and parts, and fixed maintenance and repair costs. Sewer and force main maintenance costs are based on present-day costs for operating and maintaining sewers and force mains of similar sizes in the metropolitan area. Fixed annual expenditures for wastewater pumping and treatment are based on costs of operating similar facilities in the metropolitan area and include labor, materials, heating, ventilating and equipment and building maintenance. Variable annual expenditures include the average annual power and chemicals costs over the planning period.

Equipment replacement requirements and salvage values are based on the following average service lives of the various components:

Land and Easements	Permanent
Structures	
Sewers and Force Mains	40 Years
Pumping Stations and Wastewater Treatment Plants	40 Years
Process Equipment	20 Years
Auxiliary Equipment	
Pumps and Electrical Equipment	10 Years

TABLE 8

PRESENT WORTH - ALTERNATE 1
(7% Annual Interest)

Item	Estimated Cost	Present Worth Factor	Present Worth Add	Present Worth Deduct
Project Cost	$9,180,000	1.0000	$ 9,180,000	
Annual Expenditures				
Sump Pump Operation and Maintenance	66,500	10.5940	704,501	
Sewer Operation and Maintenance	73,700	10.5940	780,778	
Sump Pump Replacement				
At End of 10 Years	631,930	0.5083	321,210	
At End of 20 Years	631,930	0.2584	163,291	
Salvage Values				
Sewers and Appurtenances	4,262,035	0.2584		$1,101,310
Easements	24,000	0.2584		6,202
		TOTALS	$11,149,780	$1,107,512
NET PRESENT WORTH - ALTERNATE 1			$10,042,268	

TABLE 9

PRESENT WORTH - ALTERNATE 2
(7% Annual Interest)

Item	Estimated Cost	Present Worth Factor	Present Worth Add	Present Worth Deduct
Project Cost	$10,338,000	1.0000	$10,338,000	
Annual Expenditures				
Sewer Operation and Maintenance	73,700	10.5940	780,778	
Salvage Values				
Sewers and Appurtenances	5,157,000	0.2584		$1,332,569
Easements	24,000	0.2584		6,202
		TOTALS	$11,118,778	$1,338,771
NET PRESENT WORTH - ALTERNATE 2			$ 9,780,007	

TABLE 10

PRESENT WORTH - ALTERNATE 3
(7% Annual Interest)

Item	Estimated Cost	Present Worth Factor	Present Worth Add	Present Worth Deduct
Project Cost	$3,125,900	1.0000	$3,125,900	
Annual Expenditures				
Sewer Operation and Maintenance	1,350	10.5940	14,302	
Force Main Operation and Maintenance	900	10.5940	9,535	
Pumping Station Operation and Maintenance	29,000	10.5940	307,226	
Wastewater Treatment				
Wastewater	42,000	10.5940	444,948	
Storm Flow	7,000	10.5940	74,158	
Equipment Replacement				
Pumping Station				
At End of 10 Years	170,750	0.5083	86,792	
At End of 20 Years	170,750	0.2584	44,122	
Wastewater Treatment				
At End of 10 Years				
Auxiliary Equipment	175,000	0.5083	88,953	
At End of 20 Years				
Auxiliary Equipment	175,000	0.2584	45,220	
Process Equipment	218,600	0.2584	56,486	
Storm Flow Treatment				
At End of 10 Years				
Auxiliary Equipment	239,000	0.5083	121,484	
At End of 20 Years				
Auxiliary Equipment	239,000	0.2584	61,758	
Process Equipment	307,400	0.2584	79,432	
		TOTAL	$4,560,316	

TABLE 10 - Continued

PRESENT WORTH - ALTERNATE 3
(7% Annual Interest)

Item	Estimated Cost	Present Worth Factor	Present Worth Add	Present Worth Deduct
Salvage Values				
Sewers	291,490	0.2584		$ 75,321
Force Main	325,800	0.2584		84,187
Pumping Station Structure	222,000	0.2584		57,365
Storm Flow Treatment Structures	341,540	0.2584		88,254
Easements	22,600	0.2584		5,840
Land	22,000	0.2584		5,685
		TOTALS	$4,560,316	$316,652
NET PRESENT WORTH - ALTERNATE 3			$4,243,664	

TABLE 11

PRESENT WORTH - ALTERNATE 4
(7% Annual Interest)

Item	Estimated Cost	Present Worth Factor	Present Worth Add	Present Worth Deduct
Project Cost	$4,664,700	1.0000	$4,664,700	
Annual Expenditures				
Sewer and Force Main				
Operation and Maintenance	1,375	10.5940	14,567	
Pumping Station				
Operation and Maintenance	13,900	10.5940	147,257	
Wastewater Treatment				
Wastewater	100,000	10.5940	1,059,400	
Storm Flow	7,000	10.5940	74,158	
Equipment Replacement				
Pumping Station				
At End of 10 Years	170,750	0.5083	86,792	
At End of 20 Years	170,750	0.2584	44,122	
Wastewater Treatment				
At End of 10 Years				
Auxiliary Equipment	437,170	0.5083	222,213	
At End of 20 Years				
Auxiliary Equipment	437,170	0.2584	112,965	
Process Equipment	546,460	0.2584	141,205	
Storm Flow Treatment				
At End of 10 Years				
Auxiliary Equipment	239,000	0.5083	121,484	
At End of 20 Years				
Auxiliary Equipment	239,000	0.2584	61,758	
Process Equipment	307,400	0.2584	79,432	
		TOTAL	$6,830,053	

TABLE 11 - Continued

PRESENT WORTH - ALTERNATE 4
(7% Annual Interest)

Item	Estimated Cost	Present Worth Factor	Present Worth Add	Present Worth Deduct
Salvage Values				
Sewers	$ 291,490	0.2584		$ 75,321
Force Main	13,662	0.2584		3,530
Pumping Station Structure	222,000	0.2584		57,365
Wastewater Treatment Structures	601,100	0.2584		155,324
Storm Flow Treatment Structures	341,540	0.2584		88,254
Easements	13,600	0.2584		3,514
Land	9,500	0.2584		2,455
		TOTALS	$6,830,053	$ 385,763
NET PRESENT WORTH - ALTERNATE 4			$6,444,290	

TABLE 12

PRESENT WORTH - ALTERNATE 5
(7% Annual Interest)

Item	Estimated Cost	Present Worth Factor	Present Worth Add	Present Worth Deduct
Project Cost	$4,253,000	1.0000	$4,253,000	
Annual Expenditures				
Sewer Operation and Maintenance	1,250	10.5940	13,243	
Force Main Operation and Maintenance	900	10.5940	9,535	
Pumping Station Operation and Maintenance	20,400	10.5940	216,118	
Wastewater Treatment				
Wastewater	42,000	10.5940	444,948	
Storm Flow	4,000	10.5940	42,376	
Equipment Replacement				
Pumping Station				
At End of 10 Years	136,615	0.5083	69,441	
At End of 20 Years	136,615	0.2584	35,301	
Wastewater Treatment				
At End of 10 Years Auxiliary Equipment	175,000	0.5083	88,953	
At End of 20 Years				
Auxiliary Equipment	175,000	0.2584	45,220	
Process Equipment	218,600	0.2584	56,486	
Storm Flow Treatment				
At End of 10 Years Auxiliary Equipment	143,450	0.5083	72,916	
At End of 20 Years				
Auxiliary Equipment	143,450	0.2584	37,067	
Process Equipment	177,600	0.2584	45,892	
		TOTAL	$5,430,496	

TABLE 12 - Continued

PRESENT WORTH - ALTERNATE 5
(7% Annual Interest)

Item	Estimated Cost	Present Worth Factor	Present Worth Add	Present Worth Deduct
Salvage Values				
Sewers	$1,250,130	0.2584		$ 323,034
Force Main	259,230	0.2584		66,985
Pumping Station Structure	170,770	0.2584		44,127
Storm Flow Treatment Structures	194,680	0.2584		50,305
Easements	21,700	0.2584		5,607
Land	22,000	0.2584		5,685
		TOTALS	$5,430,496	$ 495,743
NET PRESENT WORTH - ALTERNATE 5			$4,934,753	

TABLE 13

PRESENT WORTH - ALTERNATE 6
(7% Annual Interest)

Item	Estimated Cost	Present Worth Factor	Present Worth Add	Present Worth Deduct
Project Cost	$5,924,800	1.0000	$5,924,800	
Annual Expenditures				
Sewers and Force Main Operation and Maintenance	1,275	10.5940	13,507	
Pumping Station Operation and Maintenance	11,000	10.5940	116,534	
Wastewater Treatment				
Wastewater	100,000	10.5940	1,059,400	
Storm Flow	4,000	10.5940	42,376	
Equipment Replacement				
Pumping Station				
At End of 10 Years	136,615	0.5083	69,441	
At End of 20 Years	136,615	0.2584	35,301	
Wastewater Treatment				
At End of 10 Years				
Auxiliary Equipment	437,170	0.5083	222,214	
At End of 20 Years				
Auxiliary Equipment	437,170	0.2584	112,965	
Process Equipment	546,460	0.2584	141,205	
Storm Flow Treatment				
At End of 10 Years				
Auxiliary Equipment	143,450	0.5083	72,916	
At End of 20 Years				
Auxiliary Equipment	143,450	0.2584	37,067	
Process Equipment	177,600	0.2584	45,892	
		TOTAL	$7,893,618	

TABLE 13 - Continued

PRESENT WORTH - ALTERNATE 6
(7% Annual Interest)

Item	Estimated Cost	Present Worth Factor	Present Worth Add	Present Worth Deduct
Salvage Values				
Sewers	$1,250,130	0.2584		$ 323,034
Force Main	13,662	0.2584		3,530
Pumping Station Structure	170,770	0.2584		44,127
Wastewater Treatment Structures	601,100	0.2584		155,324
Storm Flow Treatment Structures	194,680	0.2584		50,305
Easements	12,700	0.2584		3,282
Land	9,000	0.2584		2,326
		TOTALS	$7,893,618	$ 581,928
NET PRESENT WORTH - ALTERNATE 6			$7,311,690	

Straightline depreciation is used for all components of the wastewater treatment management system except land and easements. Land and easement values are not depreciated and are assumed to have salvage values at the end of the planning period equal to their present market values.

The present worth of the alternates is summarized as follows:

Alternate	Net Present Worth
1	$10,042,268
2	9,780,007
3	4,243,664
4	6,444,290
5	4,934,753
6	7,311,690

Considering only the monetary aspect, Alternate 3 is the most cost-effective. Alternate 3 involves abandonment of the existing pumping station and force main and construction of an additional trunk sewer to parallel the existing trunk sewer. Wastewater will be conveyed by the existing outfall sewer to a pumping station located at the Area Treatment Plant site. This pumping station will pump flow to the Main Metropolitan Plant for treatment. Facilities for treating study area storm flows must be constructed at the Main Metropolitan Plant.

COST-EFFECTIVENESS STUDIES OF
SANITARY SEWERAGE SYSTEMS

TASK 2:
COST COMPARISON ASSOCIATED WITH SELECTING
INTERCEPTOR SEWER ROUTES

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METHODOLOGY

TASK 2: COST COMPARISON ASSOCIATED WITH SELECTING INTERCEPTOR SEWER ROUTES

The development of areawide waste treatment management systems includes the selection of the most cost-effective routes for sanitary interceptor sewers to serve outlying areas. These areas may be in the same drainage basin as the core city of a metropolitan area with the core city located between the areas and the areawide treatment facilities. Often, the sewer system of the core city does not have capacity for additional loads resulting in the necessity of routing new interceptors through the core city to the treatment facilities. The selection of the route or routes to serve the outlying areas involves evaluation of all feasible alternate routes. These alternates should be initially screened to find the systems which have cost-effective potential. Those alternates, with potential, should be fully evaluated according to the EPA guidelines set out in Title 40 CFR Part 35 for cost-effectiveness analysis.

The first step in a cost-effectiveness analysis of the routes for sanitary sewers is the definition of the service areas. The definition of these areas must be consistent with local and

areawide waste management system plans. With service areas defined, population and wastewater contributions, including infiltration allowances, must be determined. These projections should be on an incremental development basis determined by area, population and possible year of development. Based on these projections, staged construction may be advantageous. Information used for projection of population and wastewater loads may be obtained from flow measurements and records, census information, land use plans, engineering studies and projections by regional planning organizations.

The selection of alternate routes to be evaluated must consider environmental and social impacts in addition to monetary aspects. In addition, all alternates selected must be in accordance with the applicable Federal, State and local criteria.

All possible alternates are screened to determine those with cost-effectiveness potential. The most cost-effective alternate is determined in accordance with the EPA guidelines using present worth calculations based on a planning period of 20 years and an annual interest rate of 7 percent. This interest rate should be used until the promulgation of the Water Resources Council's "Proposed Principles and Standards for Planning Water and Related

Land Resources". After promulgation of this regulation, the annual interest rate established therein for water resources projects shall be used for cost-effectiveness analyses of the components of sanitary sewerage systems.

Total costs for each alternate must be estimated. These costs should include total values of the resources attributable to each alternate. Elements of total cost include capital construction cost, annual operation and maintenance costs and equipment replacement costs. As set out in Title 40 CFR Part 35, capital costs must include:

> "all contractors' costs of construction including overhead and profit; cost of land, relocation and right-of-way and easement acquisition; design engineering, field exploration and engineering services during construction; administrative and legal services including cost of bond sales; startup costs such as operator training; and interest during construction. Contingency allowances consistent with the level of complexity and detail of the cost estimate shall be included.".

The above items should reflect present-day costs; no attempt should be made to forecast future inflation or deflation trends.

Estimates should reflect costs in the locale of the study area. Construction costs may be obtained from bids received locally for similar construction, reference materials and from equipment and materials manufacturers. To adjust construction cost amount to reflect present-day cost, a recognized construction cost index, that accounts for changing prices for labor, material and equipment, may be used. Interest during construction is equal to (I)(P/2)(C), where:

I = the interest rate (7%) expressed as a decimal

P = the construction period in years

C = total capital expenditure in dollars,

provided the expenditures are expected to be relatively uniform over the construction period and provided the construction period is 3 years or less. Title 40 CFR Part 35 provides additional guidance if these conditions are not expected.

Annual operating and maintenance costs for each alternate must be established. These costs shall be adequate to ensure effective and dependable operation and include all costs for operating and maintaining the facilities under study including power, labor, parts, materials, overhead, chemicals and repair or replacement of equipment and structures. Annual operation

and maintenance costs may be obtained from records for similar facilities, reference materials and calculations of work required. Inflation or deflation trends shall not be considered. Annual costs should be divided between fixed costs and those dependent upon the annual quantity of wastewater collected.

Cost-effectiveness analyses also include establishing a service life for each component and salvage values for components having service lives longer than the planning period. The following service lives are to be used, unless other periods can be justified:

Land	Permanent
Structures	30-50 Years
Process Equipment	15-30 Years
Auxiliary Equipment	10-15 Years

The most cost-effective alternate is determined by present worth calculations. The general computation required is as follows:

Present Worth = Total capital construction cost

plus (+)

total capital construction cost for staged construction times single payment present worth factor based on 7% and years from time of analysis

plus (+)

average annual operation and maintenance cost times uniform series present worth factor based on 7% and 20 years (staged construction may alter this computation)

plus (+)

replacement costs, based on 7% and service life, if service life is less than 20 years

minus (-)

salvage values times single payment present worth factor based on 7% and 20 years, if service life is greater than 20 years.

In summary, considering monetary aspects only, the most cost-effective alternate route for an interceptor sewer is the alternate with the least present worth. The size and importance of the project should be reflected in the degree of sophistication and extent of effort used in its cost-effectiveness analysis.

It is important to note that the interceptor sewer route selection and its design capacity may have a substantial non-monetary impact in terms of direct environmental effects. This is due to the land use effects induced by the presence of the sewer. The land use impact is regarded as one of the most pronounced in defining community growth patterns. Often, communities that have, or exercise, little control over land use activities will have growth corridors following the new interceptor sewer routes. This

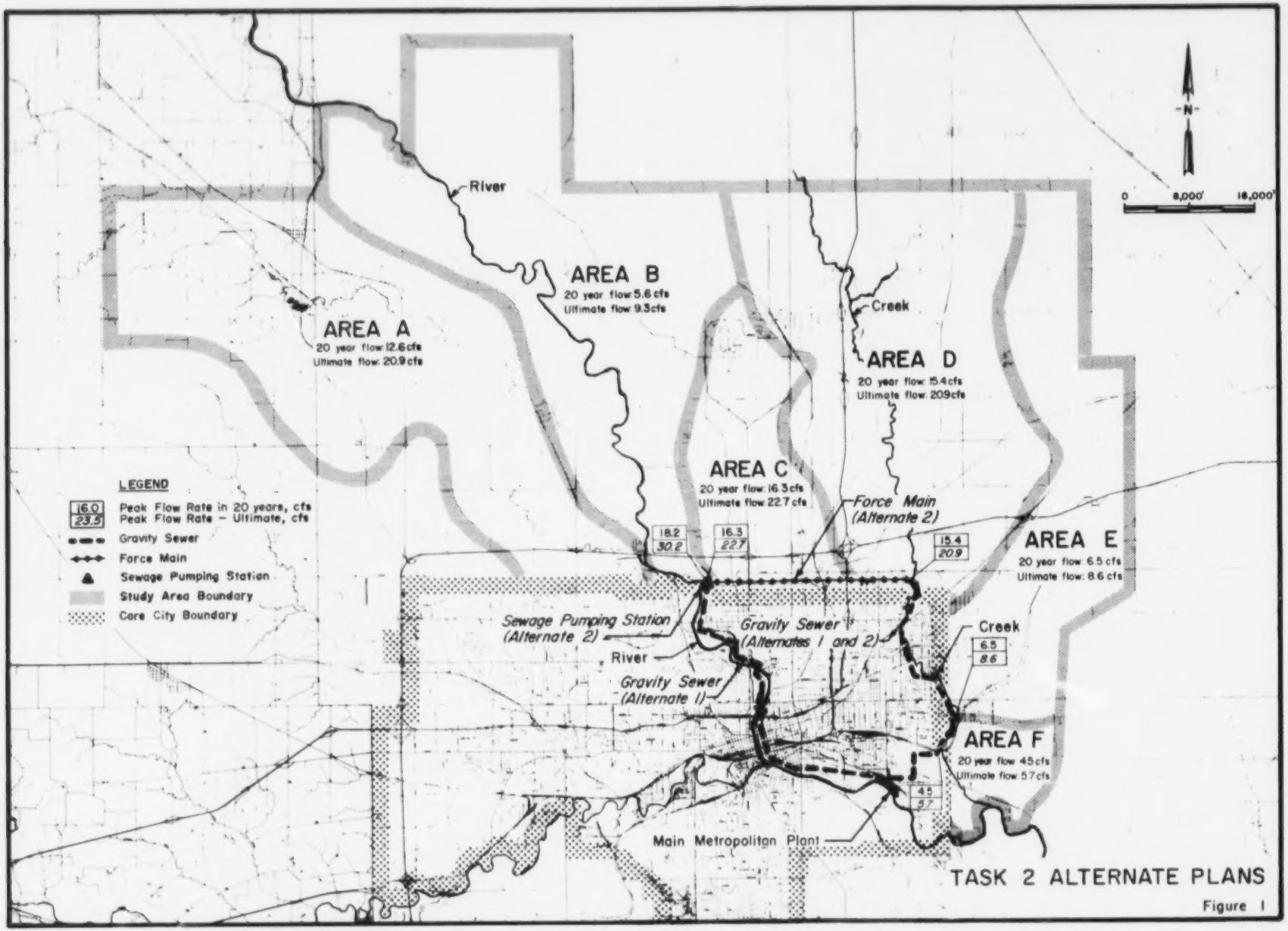
effect should be recognized in the route selection stage, brought to the attention of the public, and considered in the decision making process. This effect can be minimized by proper land use planning and strong control program so that the design of the interceptor sewer is closely correlated to the land use plan.

DEMONSTRATION

TASK 2: COST COMPARISON ASSOCIATED WITH SELECTING INTERCEPTOR SEWER ROUTES

This demonstration is an illustrative example of the cost-effectiveness analysis procedures outlined in the Methodology. The demonstration compares alternate sanitary interceptor sewer routes or combinations of routes to serve outlying areas of an areawide waste treatment management system. The scope of this study is limited to analyses of interceptor sewer routes. Similar analyses are required for other components of the management system.

The study areas for this demonstration, shown on Figure 1, are located adjacent to the north and east limits of the core city of a metropolitan area. The outer boundaries of the study areas are set in accordance with the plan for the areawide waste treatment management system applicable to the metropolitan area. The study areas are tributary to two major drainage basins, the river basin which bisects the core city and the creek basin located along the east edge of the core city. The wastewater treatment plant is located such that interceptor sewers may be constructed paralleling the river and/or the creek and convey the wastes



TASK 2 ALTERNATE PLANS

Figure 1

from the study areas by gravity. Areas A, B and C are tributary to the river basin and Areas D, E and F are tributary to the creek basin.

Following definition of service areas, incremental projections of tributary population and waste contributions are determined. Census information, land use plans, existing engineering studies and projections by the local regional planning organization are used to establish the basis for design. These data are summarized in Table 1. The population projections in Table 1 are in terms of equivalent population. For purposes of this study, projected wastewater contributions from industrial and commercial developments are converted to equivalent population and added to the projected domestic population. The industrial and commercial contributions are based on typical developments in the metropolitan area and are calculated on an area basis. The projected flow contributions are calculated on peak per capita wastewater contribution including an allowance for infiltration.

Treatment of wastewater from the study area will be provided by the areawide wastewater treatment plant. Wastewater treatment costs will be the same regardless of the route used to convey wastewater to the treatment plant. Therefore, these costs do not affect the selection of sewer routing.

TABLE 1

LAND USE, POPULATION AND FLOW DATA

	Area A	Area B	Area C	Area D	Area E	Area F	Total Area
Acreage	37,100	38,000	10,800	28,000	20,400	7,600	141,900
Land Use, %*							
Industrial	0.5	0.0	34.1	6.0	2.3	7.8	4.7
Residential	8.0	21.2	38.2	30.2	47.3	79.1	27.6
Commercial	0.0	0.0	0.0	1.6	2.9	0.0	0.8
Other	91.5	78.8	27.7	62.2	47.5	13.1	66.9
Equivalent Population							
Present	6,990	3,110	12,450	11,850	5,300	3,150	42,850
10 Years	10,820	5,200	16,740	15,900	6,840	4,480	59,980
20 Years	14,640	7,280	21,030	19,950	8,370	5,800	77,070
Ultimate	23,230	12,000	29,280	26,950	11,130	7,400	109,990
Peak Flow, cfs							
Present	6.2	2.4	9.6	9.2	4.1	2.4	33.9
10 Years	9.5	4.0	13.0	12.3	5.3	3.5	47.6
20 Years	12.6	5.6	16.3	15.4	6.5	4.5	60.9
Ultimate	20.9	9.3	22.7	20.9	8.6	5.7	88.1

*Percent of study area

All possible alternate methods for providing sewer service, in accordance with areawide waste treatment management plans, are screened for cost-effectiveness potential. While social and environmental impact factors of each alternate have been considered, discussion thereof is beyond the scope of this demonstration.

The two alternates having the highest cost-effectiveness potential are evaluated in detail in accordance with the guidelines set out in Title 40 CFR Part 35. The two alternate routes are shown on Figure 1 and are described as follows:

Alternate 1

The construction of gravity interceptor sewers to convey wastewater from the tributary service areas to the wastewater treatment plant. Areas A, B and C are served by a sewer paralleling the river through the core city. The construction of this sewer includes approximately 42,000 lineal feet of 60-inch diameter pipe. This sewer is sized for ultimate development.

Areas D, E and F are served by sewers paralleling the creek along the east boundary of the core city. In this case, preliminary cost-effectiveness analyses indicate staged construction is the more cost-effective. The first stage

construction includes approximately 21,200 lineal feet of 30-inch diameter pipe and 7,900 lineal feet of 36-inch diameter pipe. These pipes are sized for 20-year flow projections. The second stage construction includes paralleling the first stage sewer with approximately 29,100 lineal feet of pipe sized for the additional increment of flow resulting from ultimate development of the service areas.

Alternate 2

The construction of a pumping station to pump wastewater from Areas A, B and C to the creek drainage basin and the construction of a gravity interceptor sewer paralleling the creek to the wastewater treatment plant. The gravity sewer is sized to serve all study areas. This alternate includes construction in the following stages:

1. Construction of a pumping station structure adequate to accommodate pumping equipment for ultimate wastewater loads from Areas A, B and C.

2. Installation of pumping equipment adequate for waste loads expected in 10 years with equipment replacement and pumping capacity enlargement at the end of 10 years and at the end of 20 years.

3. Initial construction of approximately 26,400 lineal feet of 36-inch diameter force main with the construction of an additional 26,400 lineal feet of 30-inch diameter force main in 20 years. The combination of the two force mains has capacity for ultimate wastewater flows.

4. Initial construction of approximately 29,100 lineal feet of 48-inch diameter pipe paralleling the creek along the east boundary of the core city and an additional 36-inch diameter pipe paralleling the 48-inch diameter pipe in 20 years.

The route paralleling the river passes through high density residential and commercial districts of the core city. High bluffs located on both banks of the river and a relatively narrow floodplain complicate construction along this route.

The route paralleling the creek passes through residential and commercial districts. However, there is limited development in the floodway of the creek. The fall of the creek valley is much steeper than that of the river valley. As a result, to handle the same quantity of wastewater, sewers following the creek slope can be of smaller diameter than sewers following the river slope.

Tables 2 and 3 are summaries of the improvements required for each alternate and show the estimated costs for each improvement. Estimated unit prices reflect September, 1973, construction costs and include the costs of labor, materials, equipment, allowances for contractor's overhead and profit and for project start-up. Unit prices for constructing sewers, pumping stations and appurtenances reflect bid prices for similar construction in the locale of the study areas, adjusted to the September, 1973, Engineering News-Record Construction Cost Index of 1931.01, based on year 1913 = 100. No attempt is made to forecast future inflation or deflation trends. Estimates assume construction by contracts awarded on basis of competitive bids.

Estimated construction contract costs are determined by adding a contingency allowance of 10% to the sum of the extended unit prices to allow for unforeseen conditions arising prior to or during construction. Total estimated project costs are determined by adding to the estimated construction contract costs an allowance of 18% of such costs for technical, administrative and legal services, the costs of land and easements, and the amount of interest that will accrue during construction.

TABLE 2
ESTIMATED PROJECT COSTS - ALTERNATE 1

FIRST STAGE CONSTRUCTION

Description	Unit	Estimated Quantity	Unit Price	Extended Price
RIVER ROUTE				
60" Sewer Pipe in Place	LF	42,000	$ 60.00	$2,250,000
Crossings				
60" Pipe Jacked in Place	LF	1,700	175.00	297,500
Manholes, Tee-Section	Ea.	90	800.00	72,000
Pipe Ballast	LF	17,600	35.00	616,000
River Siphons	Ea.	2	450,000.00	900,000
CREEK ROUTE				
30" Sewer Pipe in Place	LF	21,200	25.00	530,000
36" Sewer Pipe in Place	LF	7,900	31.00	244,900
Manholes, Special	Ea.	50	850.00	42,500
Crossings				
Railroad (36" pipe)	Ea.	4	14,000.00	56,000
Highway (30" pipe)	Ea.	1	15,000.00	15,000
Concrete Encasement (36" pipe)	LF	800	50.00	40,000
Driveway Replacement	Ea.	200	150.00	30,000
Street Replacement				
30" pipe	Ea.	7	400.00	2,800
36" pipe	Ea.	4	400.00	1,600
			SUB-TOTAL	$5,368,300
Contingencies (10% ±)				536,800
ESTIMATED CONSTRUCTION CONTRACT COST				$5,905,100
Technical, Administrative and Legal Services (18% ±)				1,062,900
Easements				70,000
Interest During Construction				369,500
FIRST STAGE ESTIMATED PROJECT COST				$7,407,500

TABLE 2 (Continued)

ESTIMATED PROJECT COSTS - ALTERNATE 1

SECOND STAGE CONSTRUCTION

Description	Unit	Estimated Quantity	Unit Price	Extended Price
CREEK ROUTE				
24" Sewer Pipe in Place	LF	29,100	$ 20.00	$ 582,000
Manholes, Standard	Ea.	50	525.00	26,250
Crossings				
Railroad	Ea.	4	6,000.00	24,000
Highway	Ea.	1	6,800.00	6,800
Concrete Encasement	LF	800	35.00	28,000
Driveway Replacement	Ea.	250	150.00	37,500
Street Replacement	Ea.	11	350.00	3,850
			SUB-TOTAL	$ 708,400
Contingencies (10% ±)				70,800
ESTIMATED CONSTRUCTION CONTRACT COST				$ 779,200
Technical, Administrative and Legal Services (18% ±)				140,300
Interest During Construction				48,300
SECOND STAGE ESTIMATED PROJECT COST				$ 967,800
FIRST AND SECOND STAGE ESTIMATED PROJECT COST				$8,375,300

TABLE 3
ESTIMATED PROJECT COSTS - ALTERNATE 2

FIRST STAGE CONSTRUCTION

Description	Unit	Estimated Quantity	Unit Price	Extended Price
48" Sewer Pipe in Place	LF	29,100	$ 40.00	$1,164,000
Manholes, Special	Ea.	50	850.00	42,500
Crossings				
Railroad	Ea.	4	14,500.00	58,000
Highway	Ea.	1	12,500.00	12,500
Concrete Encasement	LF	800	70.00	56,000
Driveway Replacement	Ea.	200	150.00	30,000
Street Replacement	Ea.	11	425.00	4,675
Pumping Station				
Structure	Ea.	1	550,000.00	550,000
Equipment	Ea.	1	225,000.00	225,000
Force Main				
36" Pipe in Place	LF	26,400	43.00	1,135,200
Crossings				
Railroad	Ea.	4	14,000.00	56,000
Highway	Ea.	2	15,800.00	31,600
Interstate	Ea.	1	52,500.00	52,500
Driveway Replacement	Ea.	50	150.00	7,500
Street Replacement	Ea.	16	350.00	5,600
			SUB-TOTAL	$3,431,075
Contingencies (10% ±)				343,125
ESTIMATED CONSTRUCTION CONTRACT COST				$3,774,200
Technical, Administrative and Legal Services (18% ±)				679,400
Easements				55,500
Site Acquisition				1,500
Interest During Construction				236,800
FIRST STAGE ESTIMATED PROJECT COST				$4,747,400

TABLE 3 (Continued)
ESTIMATED PROJECT COSTS - ALTERNATE 2

SECOND STAGE CONSTRUCTION

Description	Unit	Estimated Quantity	Unit Price	Extended Price
36" Sewer Pipe in Place	LF	29,100	$ 31.00	$ 902,100
Manholes, Special	Ea.	50	850.00	42,500
Crossings				
Railroad	Ea.	4	14,000.00	56,000
Highway	Ea.	1	15,800.00	15,800
Concrete Encasement	LF	800	50.00	40,000
Driveway Replacement	Ea.	200	150.00	30,000
Street Replacement	Ea.	11	400.00	4,400
Force Main				
30" Pipe in Place	LF	26,400	36.00	950,400
Crossings				
Railroad	Ea.	4	13,000.00	52,000
Highway	Ea.	2	15,000.00	30,000
Interstate	Ea.	1	50,000.00	50,000
Driveway Replacement	Ea.	50	150.00	7,500
Street Replacement	Ea.	16	350.00	5,600
			SUB-TOTAL	$2,186,300
Contingencies (10% ±)				218,600
			ESTIMATED CONSTRUCTION CONTRACT COST	$2,404,900
Technical, Administrative and Legal Services (18% ±)				432,900
Interest During Construction				149,000
			SECOND STAGE ESTIMATED PROJECT COST	$2,986,800
			FIRST AND SECOND STAGE ESTIMATED PROJECT COST	$7,734,200

the present worth computations for each alternate are summarized in Tables 4 and 5. These computations are based on a planning period of 20 years and an annual interest rate of 7 percent.

The annual expenditures include costs of labor and materials for maintaining the gravity sewers and force main, electrical power, routine replacement of equipment and parts, and fixed maintenance and repair costs. Sewer operation and maintenance costs are based on present-day costs for operating and maintaining sewers of similar size in the core city. Fixed annual expenditures for wastewater pumping are based on costs of operating similar facilities in the core city and include labor, materials, heating, ventilating and equipment and building maintenance. Variable annual expenditures include the average annual power cost over the planning period.

Equipment replacement requirements and salvage values are based on the following average service lives of the various components:

Land and Easements	Permanent
Structures	
Sewers and Force Main	40 Years
Pumping Station	40 Years
Auxiliary Equipment	
Pumps and Electrical Equipment	10 Years

Straightline depreciation is used for all components of the sewer system except land and easements. Land and easement values

TABLE 4
PRESENT WORTH - ALTERNATE 1
(7% Annual Interest)

Item	Estimated Cost	Present Worth Factor	Present Worth Add	Present Worth Deduct
First Stage Project Cost	$7,407,500	1.0000	$7,407,500	
Second Stage Project Cost	967,800	0.2584	250,080	
Annual Expenditures				
Sewer Operation & Maintenance	7,020	10.5940	74,370	
Salvage Values				
First Stage Sewers	3,668,750	0.2584		$948,005
Easements	70,000	0.2584		18,088
		TOTALS	$7,731,950	$966,093
NET PRESENT WORTH - ALTERNATE 1			$6,765,857	

TABLE 5
PRESENT WORTH - ALTERNATE 2
(7% Annual Interest)

Item	Estimated Cost	Present Worth Factor	Present Worth Add	Present Worth Deduct
First Stage Project Cost	$4,747,400	1.0000	4,747,400	
Second Stage Project Cost	2,986,800	0.2584	771,789	
Annual Expenditures				
Sewer Operation & Maintenance	3,000	10.5940	31,782	
Force Main Operation & Maintenance	2,600	10.5940	27,544	
Pumping Station - Fixed	10,500	10.5940	111,237	
Pumping Station - Variable	16,900	10.5940	179,039	
Pumping Station Equipment Replacement				
At End of 10 Years	346,400	0.5083	176,075	
At End of 20 Years	399,620	0.2584	103,262	
Salvage Values				
First Stage Sewers	934,225	0.2584		$241,404
First Stage Force Main	880,050	0.2584		227,405
Pumping Station Structure	375,700	0.2584		97,081
Easements	55,500	0.2584		14,341
Land	1,500	0.2584		388
		TOTALS	$6,148,128	$580,619
NET PRESENT WORTH - ALTERNATE 2			$5,567,509	

are not depreciated and are assumed to have salvage values at the end of the planning period equal to their present market values.

The present worth of the alternates is summarized as follows:

Alternate	Present Worth
1	$6,765,857
2	5,567,509

Considering only the monetary aspect, Alternate 2 is the more cost-effective alternate. Alternate 2 involves construction of a wastewater pumping station, force main and an interceptor sewer in the creek valley along the east boundary of the core city to the wastewater treatment plant.

COST-EFFECTIVENESS STUDIES OF
SANITARY SEWERAGE SYSTEMS

TASK 3:
COST COMPARISON ASSOCIATED WITH WASTEWATER TREATMENT
FOR OUTLYING COMMUNITY IN METROPOLITAN AREA

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METHODOLOGY

TASK 3: COST COMPARISON ASSOCIATED WITH WASTEWATER TREATMENT FOR OUTLYING COMMUNITY IN METROPOLITAN AREA

The development of areawide waste treatment management systems includes the selection of the most cost-effective method of providing wastewater treatment facilities for an isolated, outlying community within an areawide management system. Such selection requires an economic evaluation to determine the most cost-effective sanitary sewer collection system and wastewater treatment facilities for that outlying community. It may be more feasible to treat the wastewater from an isolated community locally rather than at the treatment facilities serving a major portion of the areawide waste treatment management system area and the core city. This is particularly true when the community lies outside the tributary area being served by these treatment facilities.

This methodology outlines the procedures for determining the most cost-effective sanitary sewerage facilities for an outlying community in an areawide waste treatment management system area. However, social and environmental impacts must be considered in addition to monetary aspects. All alternates selected must be in accordance with applicable Federal, State and local criteria.

For an outlying community, cost-effective sanitary sewerage facilities can be provided by one of the following alternate methods:

1. Construct treatment facilities at location(s) near the community, utilizing existing facilities if possible.

2. Construct interim wastewater treatment facilities near the community which will allow the community to satisfy immediate needs and defer construction of the remaining transporting system to the areawide treatment facilities until the type and extent of development of the area between the interim and the areawide treatment facilities is established.

3. Provide capacity at major areawide treatment facilities and construct transporting system from the community to the areawide treatment facilities.

The first step in a cost-effectiveness analysis of the available alternates for locating wastewater treatment facilities is the definition of tne service area that includes the outlying community. This definition must be consistent with local development planning and with the areawide waste treatment management system plan. The definition of that service area

includes the boundaries of the area including future development sites and location. The area is subdivided according to existing land use plans. Land use for future development is established along with the projected population and wastewater contributions of each sub-area. The wastewater contributions include the hydraulic loading, infiltration allowances and organic contributions. These projections should be on an incremental development basis determined by area, population and year of development. Information used for projection of population and wastewater loads may be obtained from flow measurement and records, census information, land use plans, engineering studies and projections by regional planning organizations.

It is necessary to determine the receiving stream classification and the effluent requirements of the treatment facilities for each alternate. The effluent requirements may be different for the central plant and a local plant depending upon the receiving stream classification downstream from the point of discharge. Stream classification and effluent requirements may be obtained from the State regulatory agency. From the effluent requirements, design criteria and the capacity and type of treatment can be determined for each alternate.

The existing treatment facilities of the outlying community should be studied to determine capacity, condition of units, possible use of existing units and location as related to the planned development. In addition to the treatment facilities, the existing sewer system serving the community requires analyses to determine the adequacy of the system to convey the projected loadings, infiltration/inflow and the locations where new and/or larger sewers will be required.

Excessive infiltration/inflow is defined in proposed EPA guidelines as "the quantities of infiltration/inflow which can be economically eliminated from a sewer system by rehabilitation, as determined by a cost-effectiveness analysis that compares the cost for correcting the infiltration/inflow conditions with the total costs for transportation and treatment of the infiltration/inflow.". Therefore, each alternate selected for the cost-effectiveness analyses for providing sewerage facilities for an outlying community, must include a comparison between correcting infiltration/inflow conditions and transporting and treating the infiltration/inflow.

All feasible ways of providing sewerage facilities under each basic alternate are screened to determine those with cost-

effectiveness potential. The most cost-effective alternate is determined in accordance with EPA guidelines using present worth calculations based on a planning period of 20 years and an annual interest rate of 7 percent. This interest rate should be used until the promulgation of the Water Resources Council's "Proposed Principles and Standards for Planning Water and Related Land Resources". After promulgation of this regulation, the annual interest rate established therein for water resources projects shall be used for cost-effectiveness analyses of the components of sanitary sewerage systems.

Total costs for each alternate must be estimated. These costs should include total values of the resources attributable to each alternate. Elements of total cost include capital construction cost, annual operation and maintenance costs and equipment replacement costs. As set out in Title 40 CFR Part 35, capital costs must include:

> "...all contractors' costs of construction including overhead and profit; cost of land, relocation and right-of-way and easement acquisition; design engineering, field exploration and engineering services during construction; administrative and legal services including cost of bond sales; startup costs

such as operator training; and interest during construction. Contingency allowances consistent with the level of complexity and detail of the cost estimate shall be included.".

The above items should reflect present-day costs; no attempt should be made to forecast future inflation or deflation trends. Estimates should reflect costs in the locale of the study area. Construction costs may be obtained from bids received locally for similar construction, reference materials and from equipment and materials manufacturers. To adjust construction cost amount to reflect present-day cost, a recognized construction cost index, that accounts for changing prices for labor, material and equipment, may be used. Interest during construction is equal to (I)(P/2)(C), where:

I = the interest rate (7%) expressed as a decimal

P = the construction period in years

C = total capital expenditure in dollars,

provided the expenditures are expected to be relatively uniform over the construction period and provided the construction period is 3 years or less. Title 40 CFR Part 35 provides additional guidance if these conditions are not expected.

Annual operating and maintenance costs for each alternate must be established. These costs shall be adequate to ensure effective and dependable operation and include all costs for operating and maintaining the facilities under study including power, labor, parts, materials, overhead, chemicals and repair or replacement of equipment and structures. Annual operation and maintenance costs may be obtained from records for similar facilities, reference materials and calculations of work required. Inflation or deflation trends shall not be considered. Annual costs should be divided between fixed costs and those dependent upon the annual quantity of wastewater collected and treated.

Cost-effectiveness analyses also include establishing a service life for each component and salvage values for components having service lives longer than the planning period. The following service lives are to be used, unless other periods can be justified:

Land	Permanent
Structures	30-50 Years
Process Equipment	15-30 Years
Auxiliary Equipment	10-15 Years

The most cost-effective alternate is determined by present worth calculations. The general computation required is as follows:

Present Worth = Total capital construction cost

plus (+)

total capital construction cost for staged construction times single payment present worth factor based on 7% and years from time of analysis

plus (+)

average annual operation and maintenance cost times uniform series present worth factor based on 7% and 20 years (staged construction may alter this computation)

plus (+)

replacement costs, based on 7% and service life if service life is less than 20 years and

minus (-)

salvage values times single payment present worth factor based on 7% and 20 years, if service life is greater than 20 years.

Thus considering the monetary aspects only, the most cost-effective alternate is the plan having the least present worth, as determined above. It should be recognized that the alternates may have a major impact on the land use patterns of the area, in particular along the interceptor route.

The size and importance of the project should be reflected in the degree of sophistication and extent of effort used in its cost-effectiveness analysis.

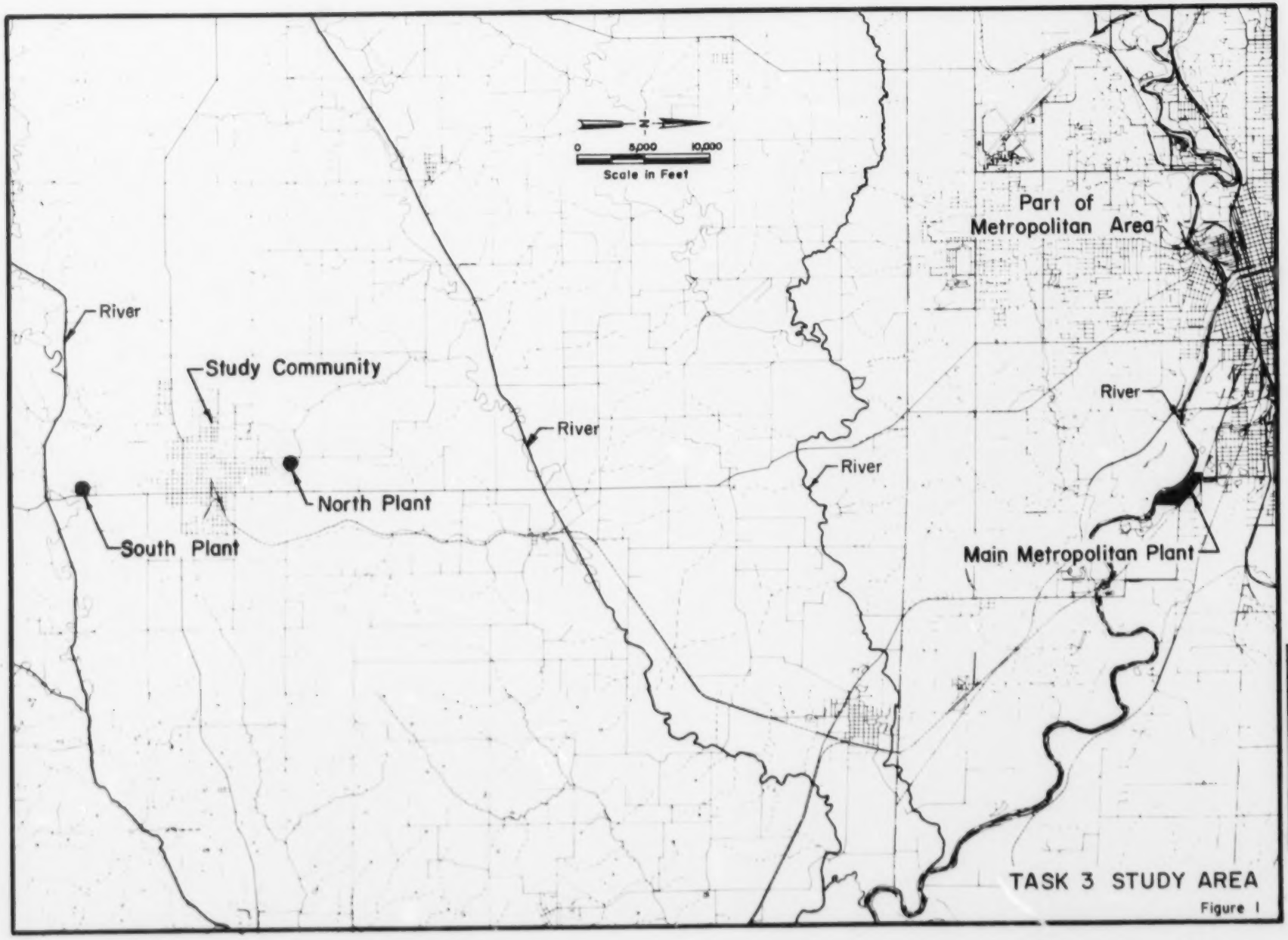
DEMONSTRATION

TASK 3: COST COMPARISON ASSOCIATED WITH WASTEWATER TREATMENT FOR OUTLYING COMMUNITY IN METROPOLITAN AREA

This demonstration is an illustrative example of the cost-effectiveness analysis procedures outlined in the Methodology. The demonstration compares alternate plans for providing sanitary sewerage facilities for an isolated, outlying community in a metropolitan area. The scope of the study includes analyses of plans for determining the location(s) of wastewater treatment facilities.

The study community, as shown on Figure 1, is located approximately 15 miles south of the presently developed portion of a metropolitan area. Rapid growth of the community in recent years has been experienced and continued growth is expected.

The high ground, extending through the study community from northeast to southwest, divides its natural drainage pattern. As shown on Figure 2, approximately two-thirds of the community (the north service areas) is served by the existing North Plant of the community. The remaining one-third (the south service area) is served by the existing South Plant of the community. Figure 2 shows existing and anticipated land use in the community, based



TASK 3 STUDY AREA

Figure 1

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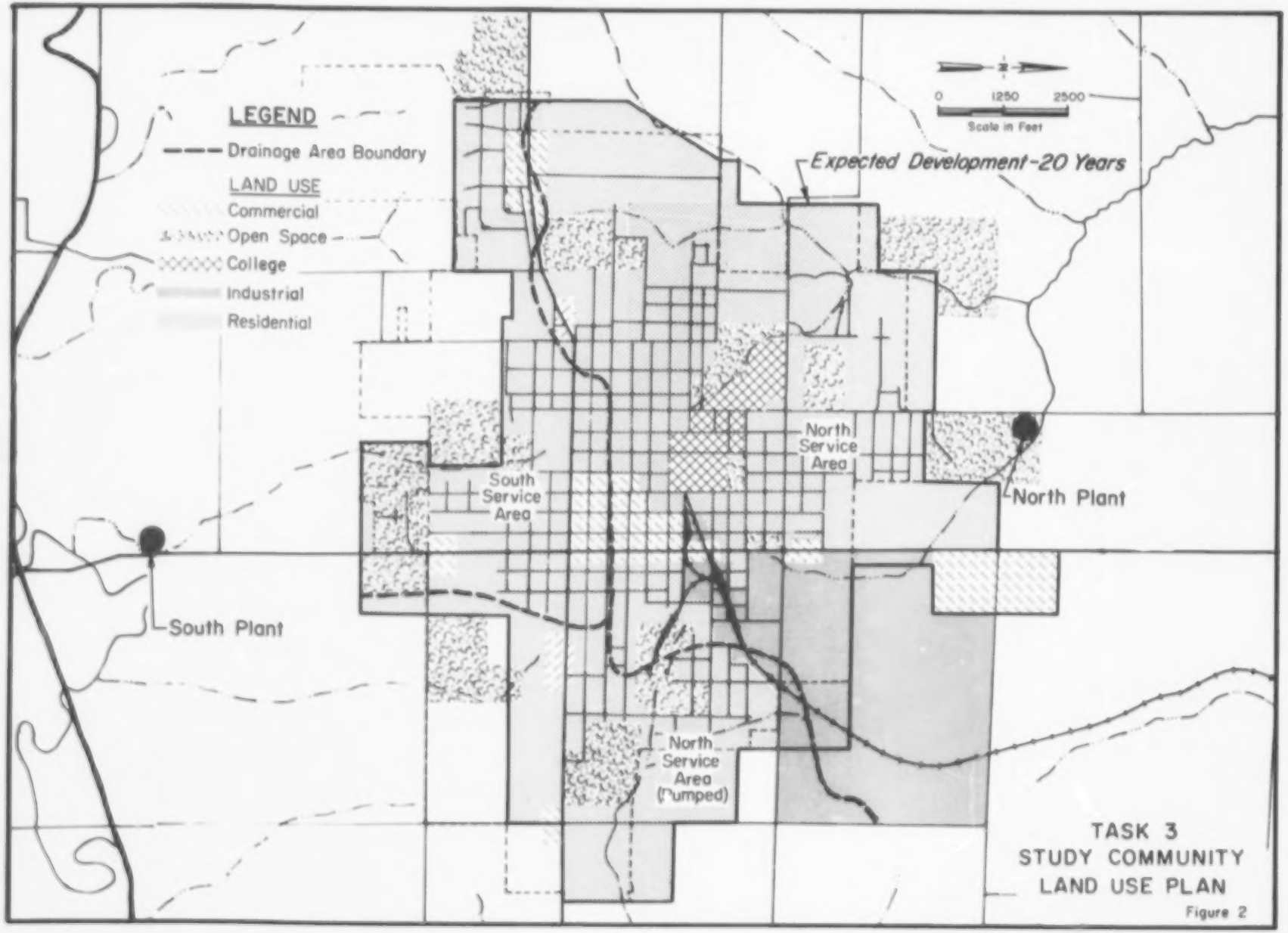

LEGEND
Drainage Area Boundary
LAND USE
Commercial
Open Space
College
Industrial
Residential
0 1250 2500
Scale in Feet
Expected Development-20 Years
North Service Area
South Service Area
North Plant
South Plant
North Service Area (Pumped)
TASK 3
STUDY COMMUNITY
LAND USE PLAN
Figure 2

78

on its adopted land use plan. The figure also shows the anticipated extent of development in the community at the end of 20 years.

Table 1 summarizes incremental projections of tributary population and waste contributions, based on the land use shown on Figure 2. The population projections in Table 1 are in terms of equivalent population. For this study, projected wastewater contributions and daily loadings from commercial and industrial developments were converted to equivalent population and were added to the domestic population. The commercial and industrial waste flows were based on typical existing development in the study community. The projected peak flow rates include peak per capita sanitary wastewater flow rates plus allowances for infiltration. The projected peak flows in Table 1 represent the most cost-effective flows based on the results of a previous separate cost-effectiveness analysis comparing costs of correcting infiltration/inflow conditions with costs of transporting and treating the infiltration/inflow. The separate cost-effective analysis indicated that it is most cost-effective to provide sewer and treatment capacity to transport and treat all flows entering the existing sewers. Separate studies indicated that flow rate increase brought about by community growth have overloaded existing trunk sewers and pumping stations. Also, many reaches of the existing collection

TABLE 1

POPULATION AND WASTEWATER DATA

Equivalent Population	Present	10 Years	20 Years
North Service Areas	6,550	9,810	11,560
South Service Area	3,650	3,790	3,940
Totals	10,200	13,600	15,500
Wastewater Flow			
Average Flow, cfs			
North Service Areas	1.01	1.52	1.79
South Service Area	0.56	0.59	0.61
Totals	1.57	2.11	2.40
Peak Flow, cfs			
North Service Areas	15.20	16.96	17.91
South Service Area	8.47	8.55	8.63
Totals	23.67	25.51	26.54
Daily Loadings			
Organic, lbs. BOD_5			
North Service Areas	1,092	1,635	1,927
South Service Area	608	632	657
Totals	1,700	2,267	2,584
Suspended Solids, lbs.			
North Service Areas	1,310	1,962	2,312
South Service Area	730	758	788
Totals	2,040	2,720	3,100

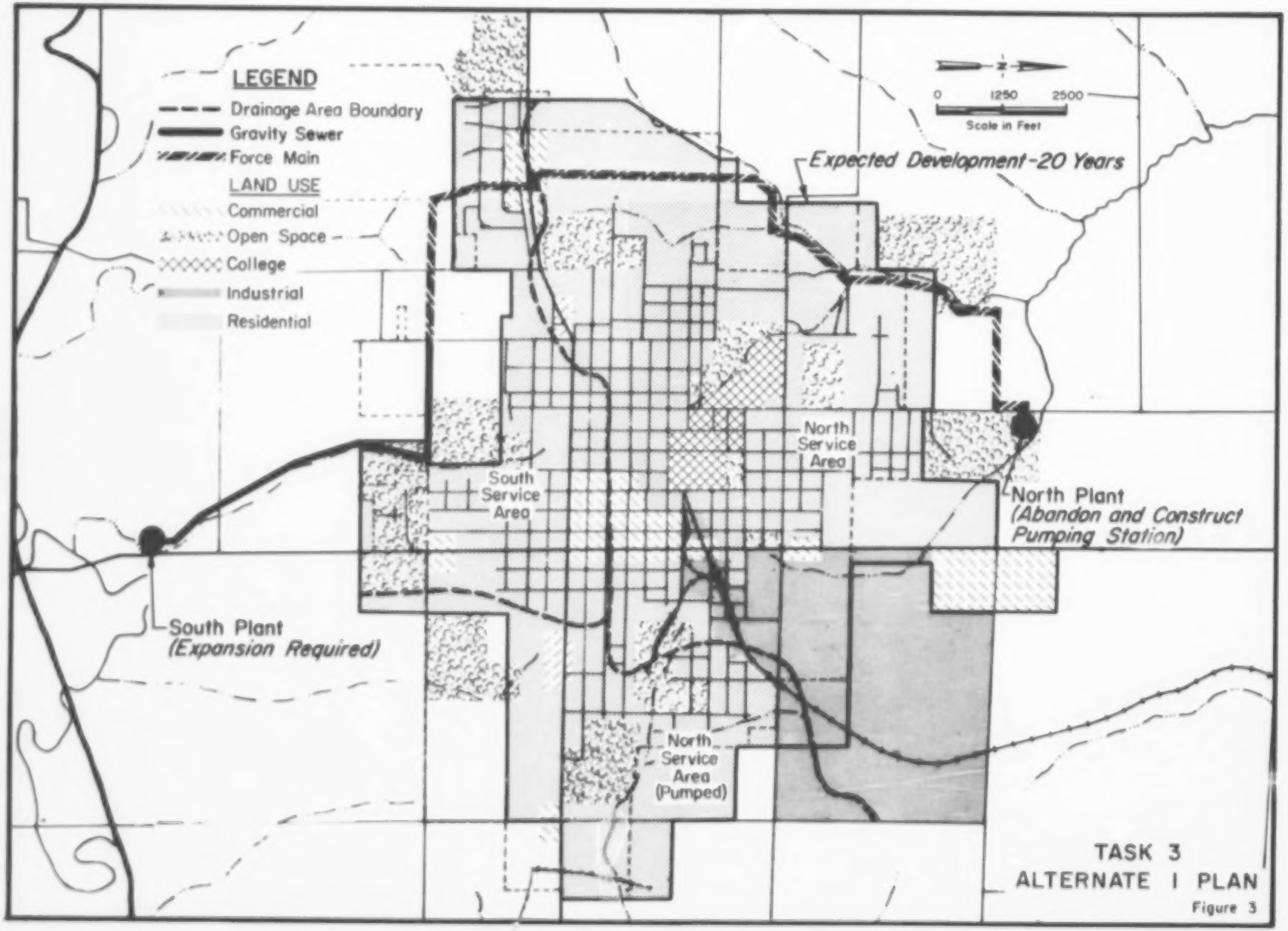
system are in poor structural condition. The structural defects include broken sewer pipe, pipe bells and joints and manholes which are unsafe or impossible to enter. Because of the poor structural conditions, extensive work on the existing collection system is required and is included in this cost-effectiveness analysis.

The growth of the community has caused a substantial increase in wastewater daily average flow rates and organic loadings. As a result, the hydraulic capacities of the two existing wastewater treatment plants have been exceeded. In addition, the older North Plant needs extensive improvements if its effluent is to meet present-day water quality criteria. Because the combined capacity of the existing plants is inadequate and because of the inability of the North Plant to meet water quality criteria, it is necessary that additional treatment capacity and increased treatment efficiency be provided. These improvements could be provided at a site or sites near the community. The study community is located in an areawide waste treatment management system. Therefore, analyses to determine whether it is more cost-effective to provide wastewater treatment facilities locally or at the centrally located treatment plant are necessary.

All possible plans for determining the location for wastewater treatment were initially screened for cost-effectiveness potential. While social and environmental impact factors of each plan have to be considered, this demonstration is limited to the monetary aspects of each plan. Of the several plans for providing wastewater treatment at a site or sites near the community, the plans described below as Alternates 1 and 2 were found to have the highest cost-effective potential. Alternates 3 and 4 have the highest cost-effective potential of plans involving treatment at a centrally located areawide facility. The four alternates selected for detailed analysis in accordance with the guidelines set out in Title 40 CFR Part 35 are shown on Figures 3, 4, 5 and 6, respectively, and are described as follows:

Alternate 1

This plan, shown on Figure 3, consists of local wastewater treatment utilizing the community's existing South Plant. An expansion of this plant is required to provide capacity for the hydraulic and organic loadings expected in 20 years from the service areas shown on Figure 3. The plant expansion includes improvements required to ensure that its effluent will meet the water quality standards set for the receiving stream.


LEGEND
Drainage Area Boundary
Gravity Sewer
Force Main
LAND USE
Commercial
Open Space
College
Industrial
Residential
N
0
1250
2500
Scale in Feet
Expected Development-20 Years
North Service Area
South Service Area
North Plant
(Abandon and Construct Pumping Station)
South Plant
(Expansion Required)
North Service Area (Pumped)
TASK 3
ALTERNATE I PLAN
Figure 3

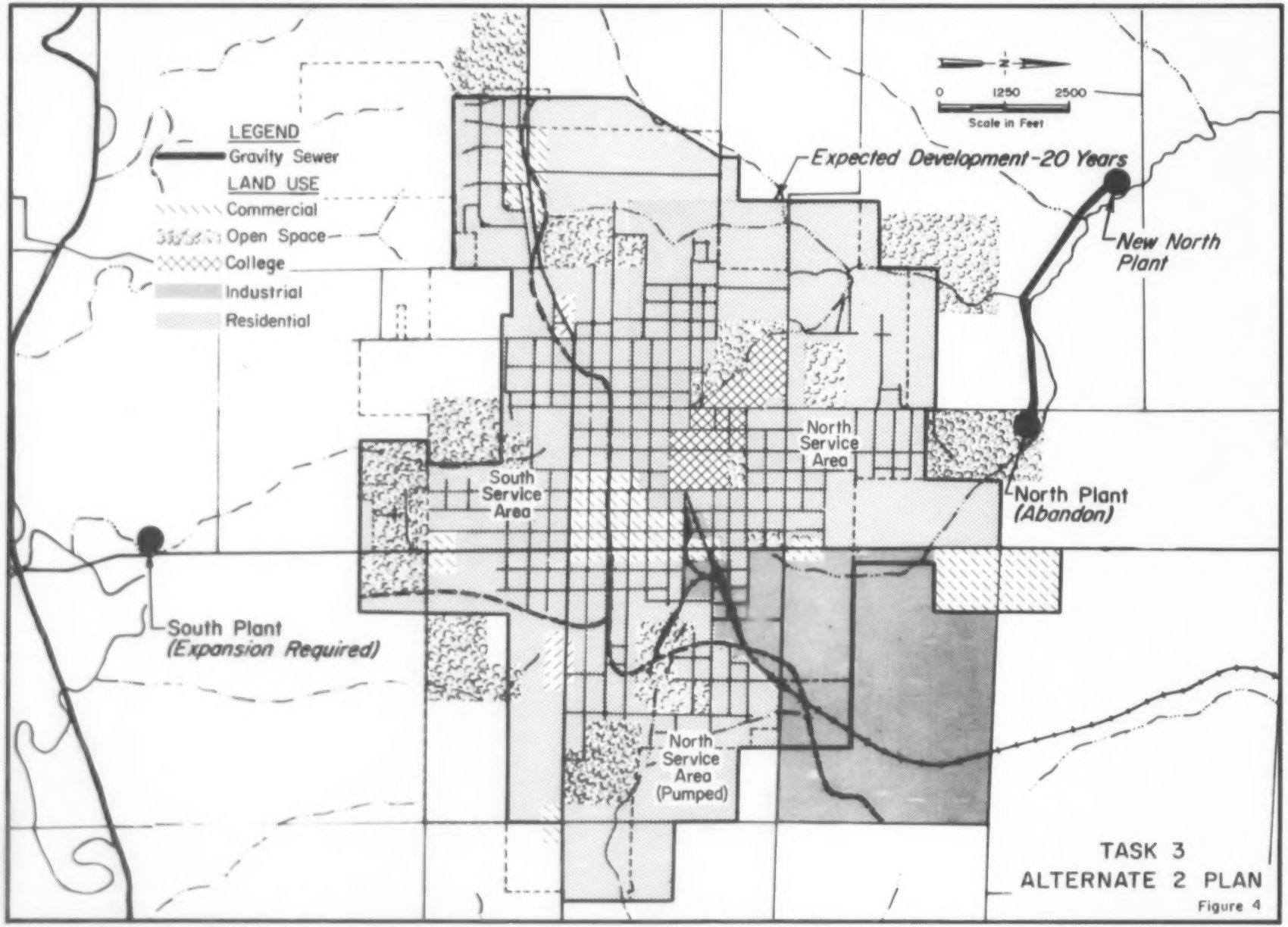
Other construction required by this alternate includes a pumping station, force main and gravity sewer to convey wastewater from the north service areas to the South Plant. As shown on Figure 3, the pumping station will be constructed at the existing North Plant site. This pumping station will discharge to a force main extending west and south through the western portion of the north service area and south and east into the south service area. The force main discharges to a gravity sewer extending east and south to the South Plant.

Upon completion of the expansion of the South Plant and construction of the pumping station, force main and gravity sewer, the North Plant will be abandoned.

Alternate 2

This alternate, shown on Figure 4, provides for local wastewater treatment at two locations. Wastewater from the south service area will be treated at the existing South Plant. New wastewater treatment facilities for the north service areas will be constructed northwest of the existing North Plant.

In addition to the new treatment facilities at a new North Plant site, this plan also includes a gravity sewer to convey


LEGEND
Gravity Sewer
LAND USE
Commercial
Open Space
College
Industrial
Residential
0 1250 2500
Scale in Feet
Expected Development-20 Years
New North Plant
North Service Area
South Service Area
North Plant (Abandon)
South Plant (Expansion Required)
North Service Area (Pumped)
TASK 3
ALTERNATE 2 PLAN
Figure 4

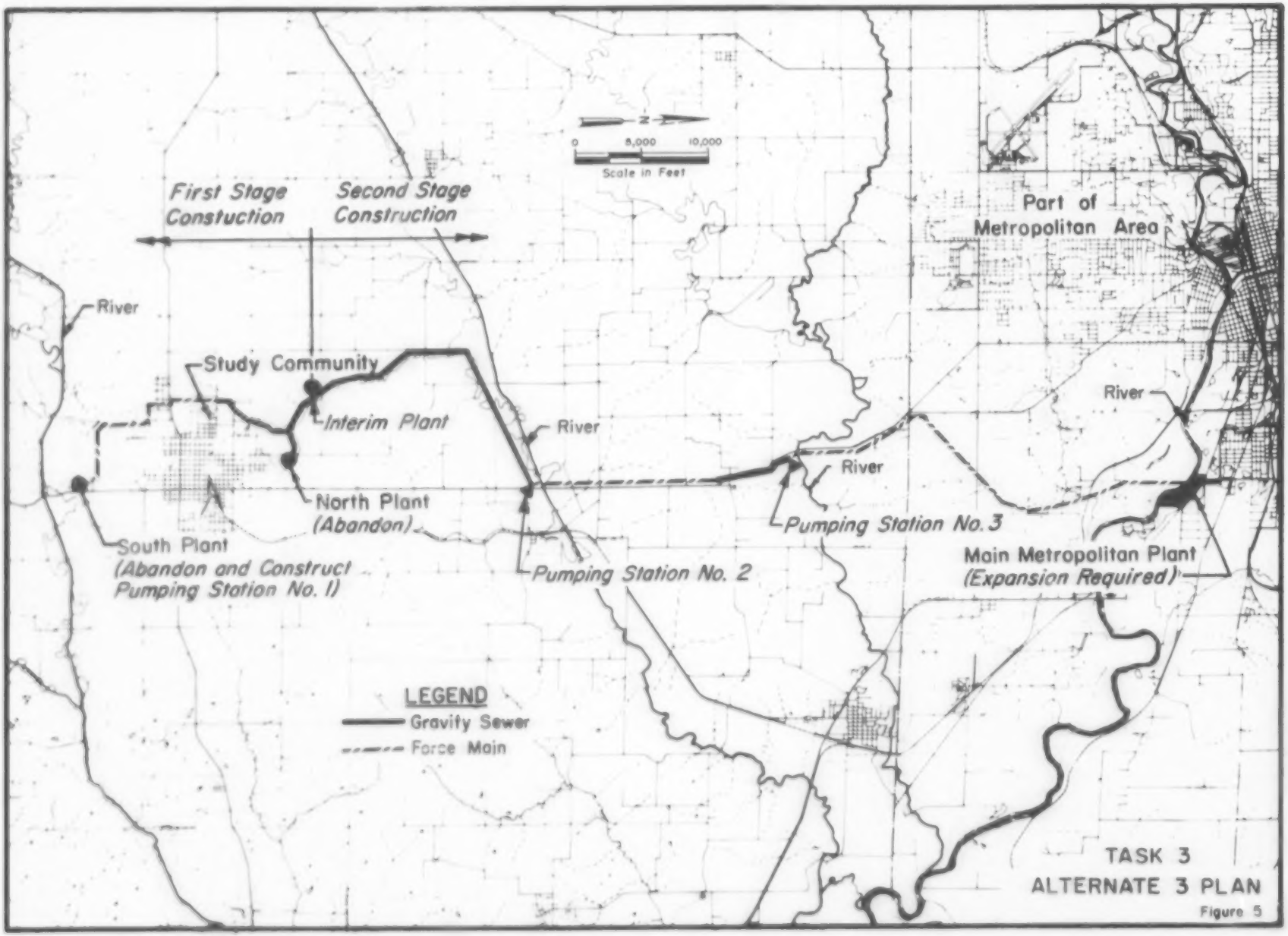
wastewater to the new North Plant and improvements at the South Plant to ensure that its effluent will meet water quality standards set for the receiving stream.

Upon completion of the new North Plant, the existing North Plant will be abandoned.

Alternate 3

This alternate, shown on Figure 5, includes the construction of an interim wastewater treatment plant at a suitable site northwest of the existing North Plant and abandonment of the existing plants. It includes pumping wastewater from the southern portion of the community through a force main to a point where it will flow by gravity to the interim plant site. Under this alternate the interim plant would be utilized for 10 years. At the end of 10 years, the interim plant will be abandoned and the wastewater will be pumped to the Main Metropolitan Plant for treatment.

In addition to the interim plant, first stage construction includes Pumping Station No. 1, located at the South Plant site and the force main and gravity sewers shown on Figure 5 required to convey wastewater from both existing plants to the interim plant. Upon completion of the first stage

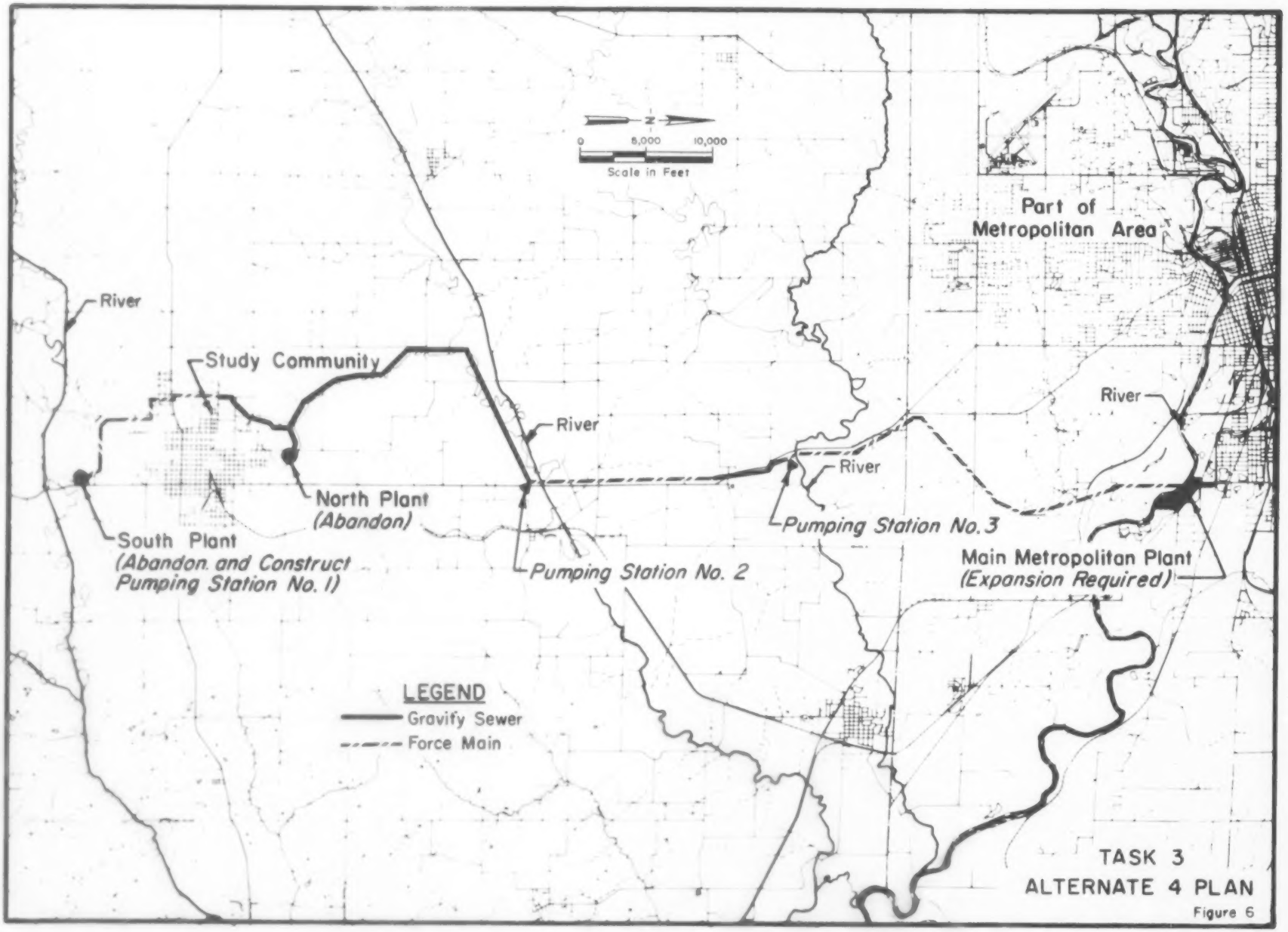

N
0
5,000
10,000
Scale in Feet
First Stage Constuction
Second Stage Construction
Part of Metropolitan Area
River
Study Community
Interim Plant
River
River
River
North Plant (Abandon)
South Plant (Abandon and Construct Pumping Station No. 1)
Pumping Station No. 3
Pumping Station No. 2
Main Metropolitan Plant (Expansion Required)
LEGEND
Gravity Sewer
Force Main
TASK 3
ALTERNATE 3 PLAN
Figure 5

construction, both existing plants will be abandoned.

Second stage construction includes Pumping Station Nos. 2 and 3 and gravity sewers and force mains necessary to convey wastewater from the interim plant to the Main Metropolitan Plant. As shown on Figure 5, this construction is complicated by the fact that it will cross portions of drainage basins of three rivers between the interim plant and the Main Metropolitan Plant. The study community will share in the capital and operating and maintenance costs of the Main Metropolitan Plant.

Alternate 4

This alternate includes the abandonment of the existing treatment plants of the outlying community and the treatment of its wastewater at the Main Metropolitan Plant. This would require ar expansion of the Main Metropolitan Plant and construction of gravity sewers, force mains and three pumping stations recessary to convey wastewater from the outlying community to the Main Metropolitan Plant. These facilities are shown on Figure 6. The location and capacities of improvemerts required by Alternate 4 are the same as described above for Alternate 3, except the interim treatment plant is

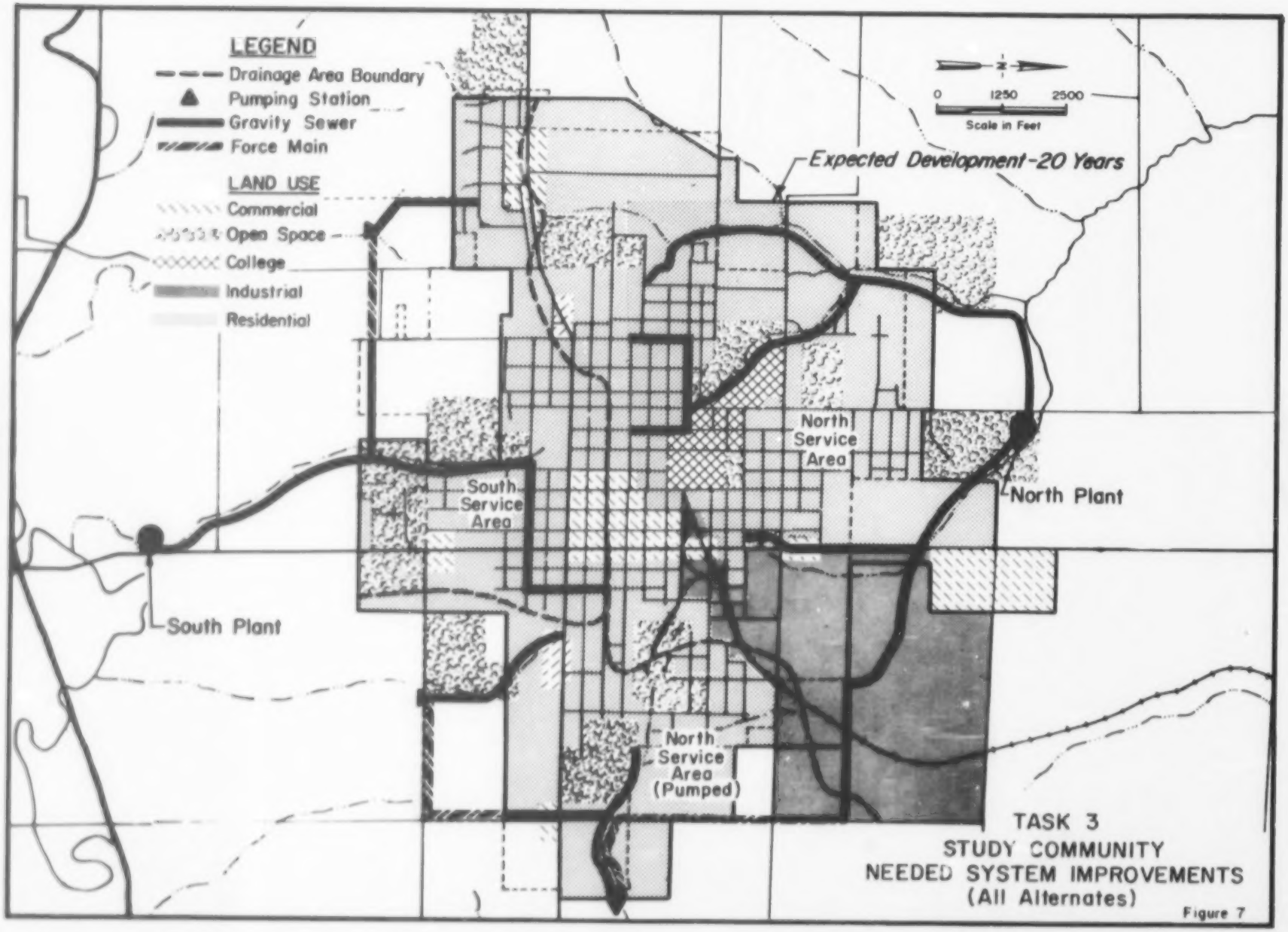

N
0
5,000
10,000
Scale in Feet
Part of
Metropolitan Area
River
Study Community
River
River
River
North Plant
(Abandon)
South Plant
(Abandon and Construct
Pumping Station No. 1)
Pumping Station No. 2
Pumping Station No. 3
Main Metropolitan Plant
(Expansion Required)
LEGEND
Gravity Sewer
Force Main
TASK 3
ALTERNATE 4 PLAN
Figure 6

not included. Both existing plants will be abandoned upon completion of the improvements described herein.

Needed System Improvements

Improvements to the outlying community's existing collection system have been included in each of the above alternates. These improvements are shown on Figure 7 and include relief sewers, pumping stations, force mains and structural repairs to the existing sewers.

Tables 2, 3, 4 and 5 are summaries of the improvements required for each alternate and show the estimated costs for each improvement. Estimated unit prices reflect September, 1973, construction costs and include the costs of labor, materials, equipment, allowances for contractor's overhead and profit and for project start-up. Unit prices for constructing sewers, pumping stations, force mains, treatment plants and appurtenances reflect bid prices for similar construction in the locale of the study community, adjusted to the September, 1973, Engineering News-Record Construction Cost Index of 1931.01, based on year 1913 = 100. No attempt is made to forecast future inflation or deflation trends. Estimates assume construction by contracts awarded on basis of competitive bids.



TASK 3
STUDY COMMUNITY
NEEDED SYSTEM IMPROVEMENTS
(All Alternates)

Figure 7

TABLE 2

ESTIMATED PROJECT COST - ALTERNATE 1

Description	Unit	Estimated Quantity	Unit Price	Extended Price
Pumping Station				
Structure	Ea.	1	$ 155,000.00	$ 155,000
Equipment	LS	1	95,000.00	95,000
Force Main				
24" Pipe in Place	LF	18,000	28.00	504,000
Highway Crossing				
2 Lane - 24" Pipe	Ea.	1	7,500.00	7,500
Surface Replacement				
Streets	Ea.	10	400.00	4,000
Driveways	Ea.	10	100.00	1,000
Gravity Sewer				
36" Pipe in Place	LF	7,900	31.00	244,900
Manholes, Special	Ea.	18	850.00	15,300
Concrete Encasement				
36" Pipe	LF	200	50.00	10,000
Wastewater Treatment (South Plant Expansion)				
Structures	LS	1	770,000.00	770,000
Process Equipment	LS	1	350,000.00	350,000
Auxiliary Equipment	LS	1	280,000.00	280,000
Relief Sewer Improvements				
Sewers and Appurtenances	LS	1	1,193,600.00	1,193,600
Pumping Stations				
Structures	LS	1	300,000.00	300,000
Equipment	LS	1	200,000.00	200,000
Force Mains and Appurtenances	LS	1	181,400.00	181,400
Sewer and Manhole Repair	LS	1	1,955,000.00	1,955,000
			SUB-TOTAL	$6,266,700
Contingencies (10%±)				626,700
			ESTIMATED CONSTRUCTION CONTRACT COST	$6,893,400
Technical, Administrative and Legal Services (18%±)				1,240,800
Easements				92,200
Site Acquisition				17,000
Interest During Construction				577,000
			ESTIMATED PROJECT COST - ALTERNATE 1	$8,820,400

TABLE 3

ESTIMATED PROJECT COST - ALTERNATE 2

Description	Unit	Estimated Quantity	Unit Price	Extended Price
Gravity Sewer				
36" Pipe in Place	LF	4,000	$ 31.00	$ 124,000
Manholes, Special	Ea.	7	850.00	5,950
Wastewater Treatment				
New North Plant				
Structures	LS	1	715,000.00	715,000
Process Equipment	LS	1	325,000.00	325,000
Auxiliary Equipment	LS	1	260,000.00	260,000
South Plant Expansion				
Structures	LS	1	170,000.00	170,000
Process Equipment	LS	1	80,000.00	80,000
Auxiliary Equipment	LS	1	60,000.00	60,000
Relief Sewer Improvements				
Sewers and Appurtenances	LS	1	1,193,600.00	1,193,600
Pumping Stations				
Structures	LS	1	300,000.00	300,000
Equipment	LS	1	200,000.00	200,000
Force Mains and Appurtenances	LS	1	181,400.00	181,400
Sewer and Manhole Repair	LS	1	1,955,000.00	1,955,000
			SUB-TOTAL	$5,569,950
Contingencies (10%±)				556,950
			ESTIMATED CONSTRUCTION CONTRACT COST	$6,126,900
Technical, Administrative and Legal Services (18%±)				1,102,800
Easements				69,300
Site Acquisition				23,000
Interest During Construction				512,500
			ESTIMATED PROJECT COST - ALTERNATE 2	$7,834,500

TABLE 4

ESTIMATED PROJECT COSTS - ALTERNATE 3

FIRST STAGE CONSTRUCTION

Description	Unit	Estimated Quantity	Unit Price	Extended Price
Pumping Station No. 1	Ea.			
Structure		1	$ 100,000.00	$ 100,000
Equipment	LS	1	60,000.00	60,000
Force Main				
18" Pipe in Place	LF	16,900	21.00	354,900
Highway Crossing				
2 Lane - 18" Pipe	Ea.	1	7,000.00	7,000
Surface Replacement				
Streets	Ea.	5	400.00	2,000
Driveways	Ea.	20	100.00	2,000
Gravel Roads	Ea.	5	200.00	1,000
Gravity Sewer				
Pipe in Place				
18"	LF	6,860	16.00	109,760
24"	LF	2,640	20.00	52,800
30"	LF	3,700	26.00	96,200
Manholes				
Standard	Ea.	22	525.00	11,550
Special	Ea.	9	850.00	7,650
Surface Replacement				
Gravel Roads	Ea.	3	200.00	600
Concrete Encasement				
18" - 30" Pipe	LF	200	40.00	8,000
Wastewater Treatment (Interim Plant)				
Structures	LS	1	940,000.00	940,000
Process Equipment	LS	1	425,000.00	425,000
Auxiliary Equipment	LS	1	335,000.00	335,000
Relief Sewer Improvements				
Sewers and Appurtenances	LS	1	1,193,600.00	1,193,600
Pumping Stations				
Structures	LS	1	300,000.00	300,000
Equipment	LS	1	200,000.00	200,000
Force Mains and Appurtenances	LS	1	181,400.00	181,400
Sewer and Manhole Repair	LS	1	1,955,000.00	1,955,000
			SUB-TOTAL	$6,343,460

TABLE 4 - (Continued)

ESTIMATED PROJECT COSTS - ALTERNATE 3

FIRST STAGE CONSTRUCTION

Balance Carried Forward	SUB-TOTAL	$6,343,460
Contingencies (10%+)		634,340
	ESTIMATED CONSTRUCTION CONTRACT COST	6,977,800
Technical, Administrative and Legal Services (18%+)		1,256,000
Easements		96,300
Site Acquisition		13,000
Interest During Construction		584,000
	FIRST STAGE ESTIMATED PROJECT COST	$8,927,100

ESTIMATED PROJECT COSTS - ALTERNATE 3

SECOND STAGE CONSTRUCTION

Description	Unit	Estimated Quantity	Unit Price	Extended Price
Pumping Station No. 2				
Structure	Ea.	1	$ 280,000.00	$ 280,000
Equipment	LS	1	170,000.00	170,000
Pumping Station No. 3				
Structure	Ea.	1	295,000.00	295,000
Equipment	LS	1	180,000.00	180,000
Force Main				
30" Pipe in Place	LF	52,300	36.00	1,882,800
Highway Crossing				
2 Lane - 30" Pipe	Ea.	1	15,000.00	15,000
Railroad Crossing				
30" Pipe	Ea.	1	13,000.00	13,000
River Crossings				
30" Pipe	LF	600	110.00	66,000
Surface Replacement				
Driveways	Ea.	10	100.00	1,000
Gravel Roads	Ea.	6	200.00	1,200

TABLE 4 - (Continued)

ESTIMATED PROJECT COSTS - ALTERNATE 3

SECOND STAGE CONSTRUCTION

Description	Unit	Estimated Quantity	Unit Price	Extended Price
Gravity Sewers				
Pipe in Place				
36"	LF	4,800	31.00	148,800
42"	LF	23,230	38.00	882,740
Manholes, Special	Ea.	75	850.00	63,750
Highway Crossings				
4 Lane - 36" Pipe	Ea.	1	45,000.00	45,000
Concrete Encasement				
42" Pipe	LF	500	60.00	30,000
Surface Replacement				
Driveways	Ea.	10	100.00	1,000
Gravel Roads	Ea.	4	200.00	800
Wastewater Treatment (Main Metropolitan Plant)				
Structures	LS	1	480,000.00	480,000
Process Equipment	LS	1	220,000.00	220,000
Auxiliary Equipment	LS	1	175,000.00	175,000
			SUB-TOTAL	$4,951,090
Contingencies (10%±)				495,110
			ESTIMATED CONSTRUCTION CONTRACT COST	$5,446,200
Technical, Administrative and Legal Services (18%±)				980,300
Easements				55,000
Site Acquisition				20,000
Interest During Construction				455,100
			SECOND STAGE ESTIMATED PROJECT COST	$6,956,600
			FIRST AND SECOND STAGE ESTIMATED PROJECT COST	$15,883,700

TABLE 5

ESTIMATED PROJECT COST - ALTERNATE 4

Description	Unit	Estimated Quantity	Unit Price	Extended Price
Pumping Station No. 1				
Structure	Ea.	1	$ 100,000.00	$ 100,000
Equipment	LS	1	60,000.00	60,000
Pumping Station No. 2				
Structure	Ea.	1	280,000.00	280,000
Equipment	LS	1	170,000.00	170,000
Pumping Station No. 3				
Structure	Ea.	1	295,000.00	295,000
Equipment	LS	1	180,000.00	180,000
Force Mains				
Pipe in Place				
18"	LF	16,900	21.00	354,900
30"	LF	52,300	36.00	1,882,800
Highway Crossings				
2 Lane - 18" Pipe	Ea.	1	7,000.00	7,000
2 Lane - 30" Pipe	Ea.	1	15,000.00	15,000
Railroad Crossing				
30" Pipe	Ea.	1	13,000.00	13,000
River Crossings				
30" Pipe	LF	600	110.00	66,000
Surface Replacement				
Streets	Ea.	5	400.00	2,000
Driveways	Ea.	30	100.00	3,000
Gravel Roads	Ea.	11	200.00	2,200
Gravity Sewers				
Pipe in Place				
18"	LF	6,860	16.00	109,760
24"	LF	2,640	20.00	52,800
30"	LF	3,700	26.00	96,200
36"	LF	4,800	31.00	148,800
42"	LF	23,230	38.00	882,740
Manholes				
Standard	Ea.	22	525.00	11,550
Special	Ea.	84	850.00	71,400
Highway Crossings				
4 Lane - 36" Pipe	Ea.	1	45,000.00	45,000
Concrete Encasement				
18" - 30" Pipe	LF	200	40.00	8,000
42" Pipe	LF	500	60.00	30,000

TABLE 5 - (Continued)

ESTIMATED PROJECT COST - ALTERNATE 4

Description	Unit	Estimated Quantity	Unit Price	Extended Price
Surface Replacement				
Driveways	Ea.	10	$ 100.00	1,000
Gravel Roads	Ea.	7	200.00	1,400
Wastewater Treatment (Main Metropolitan Plant)				
Structures	LS	1	480,000.00	480,000
Process Equipment	LS	1	220,000.00	220,000
Auxiliary Equipment	LS	1	175,000.00	175,000
Relief Sewer Improvements				
Sewers and Appurtenances	LS	1	1,193,600.00	1,193,600
Pumping Stations				
Structures	LS	1	300,000.00	300,000
Equipment	LS	1	200,000.00	200,000
Force Mains and Appurtenances	LS	1	181,400.00	181,400
Sewer and Manhole Repair	LS	1	1,955,000.00	1,955,000
			SUB-TOTAL	9,594,550
Contingencies (10%+)				959,450
			ESTIMATED CONSTRUCTION CONTRACT COST	$10,554,000
Technical, Administrative and Legal Services (18%+)				1,899,700
Easements				151,300
Site Acquisition				20,000
Interest During Construction				883,800
			ESTIMATED PROJECT COST - ALTERNATE 4	$13,508,800

Estimated construction contract costs are determined by adding a contingency allowance of 10% to the sum of the extended unit prices to allow for unforeseen conditions arising prior to or during construction. Total estimated project costs are determined by adding to the estimated construction contract costs an allowance of 18% of such costs for technical, administrative and legal services, the costs of land and easements, and the amount of interest that will accrue during construction.

The present worth computations for each alternate are summarized in Tables 6, 7, 8 and 9. These computations are based on a planning period of 20 years and an annual interest rate of 7 percent.

The annual expenditures include costs of labor and materials for maintaining the gravity sewers and force mains, electrical power, routine replacement of equipment and parts, and fixed maintenance and repair costs. Sewer and force main maintenance costs are based on present-day costs for operating and maintaining sewers and force mains of similar size in the metropolitan area. Fixed annual expenditures for wastewater pumping and treatment are based on costs of operating similar facilities in the metropolitan area and include labor, materials, heating, ventilating and equipment and building maintenance. Variable annual expenditures include average annual power and chemicals costs over the planning period.

TABLE 6

PRESENT WORTH - ALTERNATE 1
(7% Annual Interest)

Item	Estimated Cost	Present Worth Factor	Present Worth Add	Present Worth Deduct
Project Cost	$8,820,400	1.0000	$ 8,820,400	
Annual Expenditures				
Sewer Operation and Maintenance	6,550	10.5940	69,391	
Force Mains Operation and Maintenance	4,370	10.5940	46,296	
Pumping Stations-Fixed	12,000	10.5940	127,128	
Pumping Stations-Variable	8,800	10.5940	93,227	
Wastewater Treatment-Fixed	35,000	10.5940	370,790	
Wastewater Treatment-Variable	38,000	10.5940	402,572	
Equipment Replacement				
Pumping Stations				
At End of 10 Years	409,700	0.5083	208,250	
At End of 20 Years	409,700	0.2584	105,866	
Wastewater Treatment				
At End of 10 Years				
Auxiliary Equipment	388,900	0.5083	197,678	
At End of 20 Years				
Process Equipment	486,100	0.2584	125,608	
Auxiliary Equipment	388,900	0.2584	100,492	
Salvage Values				
Sewers	2,374,100	0.2584		$ 613,467
Existing System Sewers and Manhole Repair	1,357,600	0.2584		350,804
Force Mains	484,600	0.2584		125,221
Pumping Station Structures	316,000	0.2584		81,654
Wastewater Treatment Structures	534,700	0.2584		138,166
Easements	92,200	0.2584		23,824
Land	17,000	0.2584		4,393
		TOTALS	$10,667,698	$1,337,529

NET PRESENT WORTH - ALTERNATE 1 $ 9,330,169

TABLE 7

PRESENT WORTH - ALTERNATE 2
(7% Annual Interest)

Item	Estimated Cost	Present Worth Factor	Present Worth Add	Present Worth Deduct
Project Cost	$7,834,500	1.0000	$ 7,834,500	
Annual Expenditures				
Sewer Operation and Maintenance	6,200	10.5940	65,683	
Force Main Operation and Maintenance	2,600	10.5940	27,544	
Pumping Stations-Fixed	9,000	10.5940	95,346	
Pumping Stations-Variable	4,000	10.5940	42,376	
Wastewater Treatment-Fixed	40,100	10.5940	424,819	
Wastewater Treatment-Variable	35,000	10.5940	370,790	
Equipment Replacement				
Pumping Stations				
At End of 10 Years	277,800	0.5083	141,206	
At End of 20 Years	277,800	0.2584	71,784	
Wastewater Treatment				
At End of 10 Years				
Auxiliary Equipment	444,400	0.5083	225,889	
At End of 20 Years				
Process Equipment	562,500	0.2584	145,350	
Auxiliary Equipment	444,400	0.2584	114,833	
Salvage Values				
Sewers	919,100	0.2584		$ 237,495
Existing System Sewers and Manhole Repair	1,357,600	0.2584		350,804
Force Mains	126,000	0.2584		32,558
Pumping Station Structures	208,300	0.2584		53,825
Wastewater Treatment Structures	614,600	0.2584		158,813
Easements	69,300	0.2584		17,907
Land	23,000	0.2584		5,943
		TOTALS	$ 9,560,120	$ 857,345
NET PRESENT WORTH - ALTERNATE 2			$ 8,702,775	

TABLE 8

PRESENT WORTH - ALTERNATE 3
(7% Annual Interest)

Item	Estimated Cost	Present Worth Factor	Present Worth Add	Present Worth Deduct
First Stage Project Cost	$8,927,100	1.0000	$ 8,927,100	
Second Stage Project Cost	6,956,600	0.5083	3,536,040	
Annual Expenditures				
First 10 Years				
Sewer Operation and Maintenance	7,500	7.0236	52,677	
Force Mains Operation and Maintenance	4,265	7.0236	29,956	
Pumping stations-Fixed	12,000	7.0236	84,283	
Pumping Stations-Variable	6,660	7.0236	46,777	
Wastewater Treatment-Fixed	35,000	7.0236	245,826	
Wastewater Treatment-Variable	38,000	7.0236	226,897	
Second 10 Years				
Sewer Operation and Maintenance	10,260	3.5704	36,632	
Force Main Operation and Maintenance	7,750	3.5704	27,671	
Pumping Stations-Fixed	18,000	3.5704	64,267	
Pumping Stations-Variable	25,660	3.5704	91,616	
Wastewater Treatment-Fixed	17,000	3.5704	60,697	
Wastewater Treatment-Variable	18,000	3.5704	64,267	
Equipment Replacement				
Pumping Stations				
At End of 10 Years	361,100	0.5083	183,547	
At End of 20 Years	847,200	0.2584	218,916	
Wastewater Treatment				
At End of 20 Years				
Auxiliary Equipment	243,100	0.2584	62,817	
		SUB-TOTAL	$13,959,986	

TABLE 8 - (Continued)

PRESENT WORTH - ALTERNATE 3
(7% Annual Interest)

Item	Estimated Cost	Present Worth Factor	Present Worth Add	Present Worth Deduct
Salvage Values				
First Stage				
Sewers	$1,027,800	0.2584		$ 265,584
Existing System Sewers and Manhole Repair	1,357,600	0.2584		350,804
Force Mains	380,800	0.2584		98,399
Pumping Station Structures	277,800	0.2584		71,784
Easements	96,300	0.2584		24,884
Land	13,000	0.5083		6,608
Second Stage				
Sewers	1,220,900	0.2584		315,481
Force Mains	2,060,400	0.2584		532,407
Pumping Station Structures	598,900	0.2584		154,756
Wastewater Treatment Structures	500,000	0.2584		129,200
Process Equipment	152,800	0.2584		39,484
Easements	55,000	0.2584		14,212
Land	20,000	0.2584		5,168
		TOTALS	$13,959,986	$2,008,771
NET PRESENT WORTH - ALTERNATE 3			$11,951,215	

TABLE 9

PRESENT WORTH - ALTERNATE 4
(7% Annual Interest)

Item	Estimated Cost	Present Worth Factor	Present Worth Add	Present Worth Deduct
Project Cost	$13,508,800	1.0000	$13,508,800	
Annual Expenditures				
Sewer Operation and Maintenance	10,260	10.5940	108,694	
Force Mains Operation and Maintenance	7,750	10.5940	82,104	
Pumping Stations-Fixed	18,000	10.5940	190,692	
Pumping Stations-Variable	25,660	10.5940	271,842	
Wastewater Treatment-Fixed	17,000	10.5940	180,098	
Wastewater Treatment-Variable	18,000	10.5940	190,692	
Equipment Replacement				
Pumping Stations				
At End of 10 Years	847,200	0.5083	430,632	
At End of 20 Years	847,200	0.2584	218,916	
Wastewater Treatment				
At End of 10 Years				
Auxiliary Equipment	243,000	0.5083	123,517	
At End of 20 Years				
Process Equipment	305,500	0.2584	78,941	
Auxiliary Equipment	243,000	0.2584	62,791	
Salvage Values				
Sewers	2,235,700	0.2584		$ 577,705
Existing System Sewers and Manhole Repair	1,357,600	0.2584		350,804
Force Mains	2,388,500	0.2584		617,188
Pumping Station Structures	677,100	0.2584		174,963
Wastewater Treatment Structures	333,300	0.2584		86,125
Easements	151,300	0.2584		39,096
Land	20,000	0.2584		5,168
		TOTALS	$15,447,719	$1,851,049
NET PRESENT WORTH - ALTERNATE 4			$13,596,670	

Equipment replacement requirements and salvage values are based on the following average service lives of the various components:

Land and Easements	Permanent
Structures	
Sewer and Force Main	40 Years
Pumping Stations and Wastewater Treatment Plants	40 Years
Process Equipment	20 Years
Auxiliary Equipment	
Pumps and Electrical Equipment	10 Years

Straightline depreciation is used for all components of the wastewater treatment management system except land and easements. Land and easement values are not depreciated and are assumed to have salvage values at the end of the planning period equal to their present market values.

The present worth of the alternates is summarized as follows:

Alternate	Net Present Worth
1	$ 9,330,169
2	8,702,775
3	11,951,215
4	13,596,670

Considering only the monetary aspect, Alternate 2 is the most cost-effective. Alternate 2 involves abandonment of the existing North Plant, construction of a new North Plant and an interceptor sewer to transport wastewater to the plant and an expansion of the South Plant.